OIL SHALE TRACT C-b

ENVIRONMENTAL AND EXPLORATION PROGRAM

SUMMARY REPORT #1

(Through November 30, 1974)

C-b SHALE OIL PROJECT

Ashland Oil, Inc.
Atlantic Richfield Company, Operator
Shell Oil Company
The Oil Shale Corporation

U. S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

TRACT C-b

SUMMARY REPORT #1

(Through November 30, 1974)

Submitted to:

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By:

C-b Shale Oil Project

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February 10, 1975

TRACT C-b
SUMMARY REPORT #1
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INTRODUCTION

The Tract C-b Lessees have been requested by the U.S.G.S. Area Oil Shale Supervisor to submit various data collected during each seasonal quarter. Quarterly Report #1 (through November 30, 1974), consisting of seven volumes of data and reports by Lessees' Staff and Contractors was submitted on January 14, 1975. This Summary Report #1 describes the type of data which are now on file with the Area Oil Shale Supervisor

Summary Report #1 is an overview of Quarterly Report #1. It is organized to be consistent with Quarterly Report #1. For example, Section I in both reports is "Pre-Exploration Environmental Reconnaissance Surveys," the preliminary field investigations carried out to ensure that exploration and environmental studies are not planned in sensitive habitat, vegetation or archaeological areas. Also where appropriate, this Summary Report #1 includes examples of data reported in the Quarterly Report #1 as well as a general description of the programs. For more in-depth data review, interested parties are referred to the Area Oil Shale Supervisor.

The following tabulation outlines the current activity on Tract C-b and the Consultants or Lessee Staffs which are carrying out the programs:

Surface Water	U.S.G.S. Water Resources Division Colorado River Water Conservation District
Ground Water and Core Drilling	Local Drilling Contractors Staff Hydrologists Golder Associates (Hydrology/Mineability)
Air Quality and Meteorology	Radian Corporation Marlatt and Associates E. G. & G.
Biology	Woodward-Clyde Consultants
Soils	Woodward-Clyde Consultants
Archaeology	Calvin H. Jennings (Colorado State University)
Micro-Environmental	Ball Brothers Research Corporation Staff Biologists

A folded map is included at the end of Summary Report #1 depicting the locations of the numerous activities and monitoring sites.

While this project represents an extremely comprehensive exploration and environmental program, it will undoubtedly undergo changes as data are accumulated. Some of the data now being collected will prove not to be needed or insignificant, and the respective programs will be modified. Other data, not now being gathered, may be necessary additions. Through early dissemination of the data by means of the Quarterly Reports and Summary Reports, the Tract C-b Lessees welcome any additional input that would be helpful towards achieving the objectives intended by the U. S. Department of Interior Prototype Oil Shale Leasing Program.

I

PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS

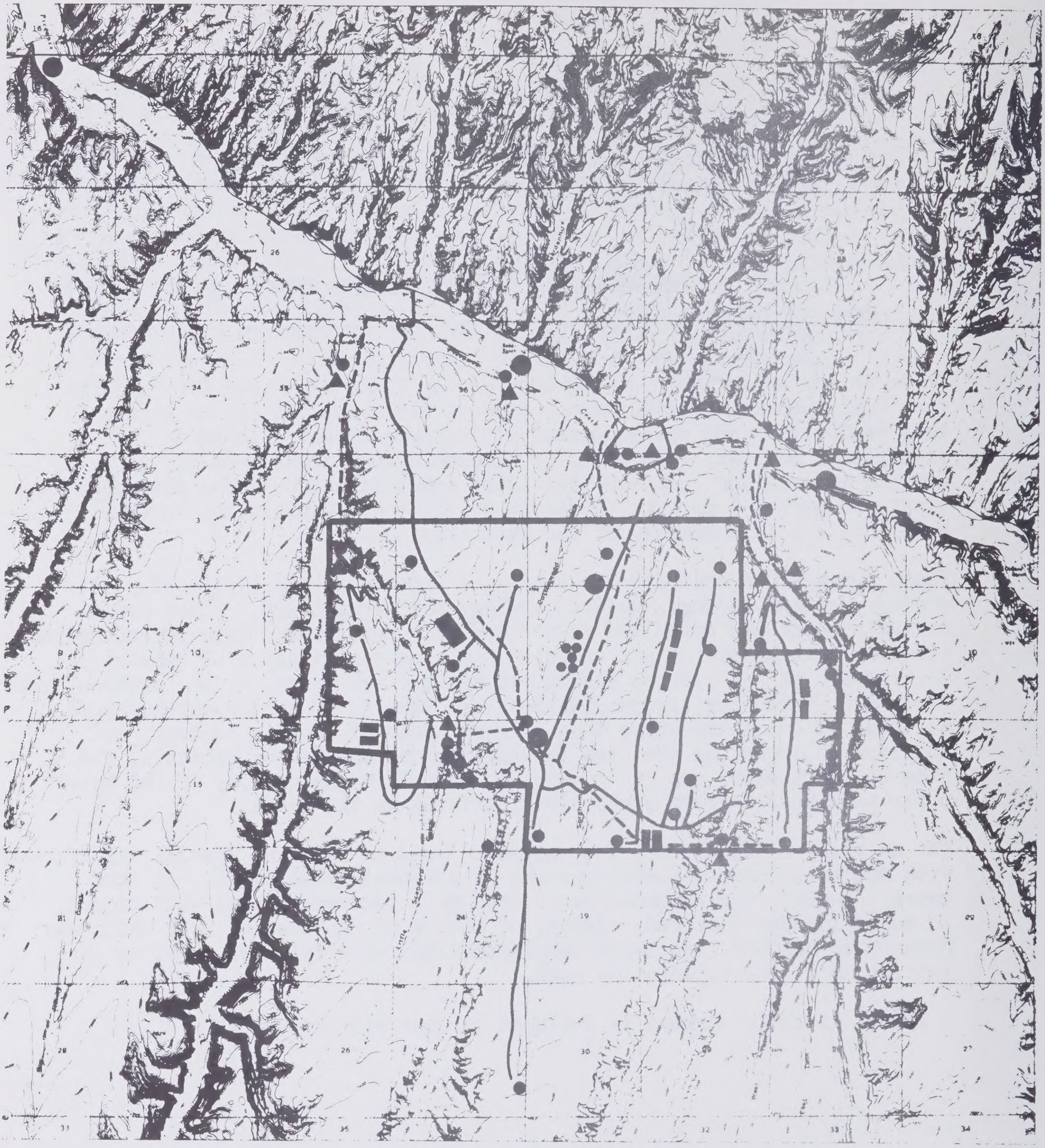
Prior to any appreciable disturbance of the Tract C-b area, Pre-Exploration Environmental Reconnaissance Surveys are conducted (1) to ensure that exploration and environmental activities are not planned in significant habitat, vegetation or archaeological areas, and (2) to provide information necessary for later rehabilitation of the disturbed areas. Figure I-1 depicts the areas of these pre-exploration surveys and Table I-1 is a summary of the investigations.

These surveys are conducted by a team of experts in the fields of plant ecology, animal ecology, aquatic ecology and archaeology. Plant communities present are noted and their condition described. Rare or endangered plant or animal species are searched for, and significance of habitat is described. If any rare or endangered species are found, or any archaeological areas are discovered, recommendations are made as to action which should be taken to avoid impacting them. In the area of aquatic ecology, in addition to surveying the area for significant species or habitats, the team collects water quality samples to ascertain the quality of the water prior to disturbance of nearby land surfaces on the Tract.

The majority of the surveyed areas were found to be of no special significance with regard to environmental systems or archaeological sites. In some cases, however, the reconnaissance team made recommendations with regard to modifying the location, timing, or method of exploration work which was planned to be done, and these recommendations were followed prior to the initiation of the exploration work.

A report of these surveys is included in Quarterly Report #1.

FIGURE I-1



MAP OF PRE-EXPLORATION SURVEYS

- ROADS
- POWERLINES
- SUPPORT FACILITIES
- AIR QUALITY STATION
- CORE HOLES
- WATER GAUGING SITES
- BIOLOGICAL OBSERVATION PLOTS

TABLE I-1

STATUS OF PRE-EXPLORATION ENVIRONMENTAL INVESTIGATIONS - 1/1/75

LOCATION	ARCHAEOLOGICAL EVALUATION	PLANT, ANIMAL, AND AQUATIC EVALUATION
Coreholes SG-1 through SG-21 and Roads	X	X
Surface Water Stations 1 through 13	X	---1
Support Facilities	X*	X
Air Quality Sites (5) and Meteorological Tower	X	X
Alluvial Wells ("A" Series) 1 through 13	X	X
Relocation of Coreholes SG-6 and SG-7	X	X
Relocation of Corehole SG-17	X*	X
Relocation of Roads to SG-4 and SG-17	X	X
Biological Observation Plots	X*	X*
Powerlines	X	---2
Old Coreholes Cb-1, Cb-2, Cb-3, and Cb-4	X*	X
Old Coreholes 71-1, 71-2, 71-3, TG2-1, TG3-2 & Fed 2-b	X	X
Road to SG-18 ("CH-18")	X	X
Area Surrounding Aquifer Test Site	X	X
Road from Piceance Creek to Cottonwood and Sorghum Gulches	X	X
Road from Piceance Creek to Tract	X	---3
Road between Cottonwood and Surghum Gulches	X	X

* evaluation received through verbal communication; no written report
---1 installed by USGS prior to biological reconnaissance; minimal disturbance
---2 minimal biological disturbance
---3 judgment that improvement of already heavily-travelled road would not result in increase in biological disturbance

ENVIRONMENTAL BASELINE MONITORING PROGRAMS

II A SURFACE WATER

On April 23, 1974, the required environmental data and monitoring programs were commenced for the Surface Water Program. These consist of:

1. Surface water stream gauging and water quality analyses, and

2. Inventory of natural surface features such as seeps and springs.

The Lease requires that surface water gauging stations be located on the major drainages of Tract C-b and, as defined by the Area Oil Shale Supervisor, upstream and downstream of the Leased Lands. Records must be maintained of all data collected:

1. Stream flow

2. Water temperature

3. Precipitation

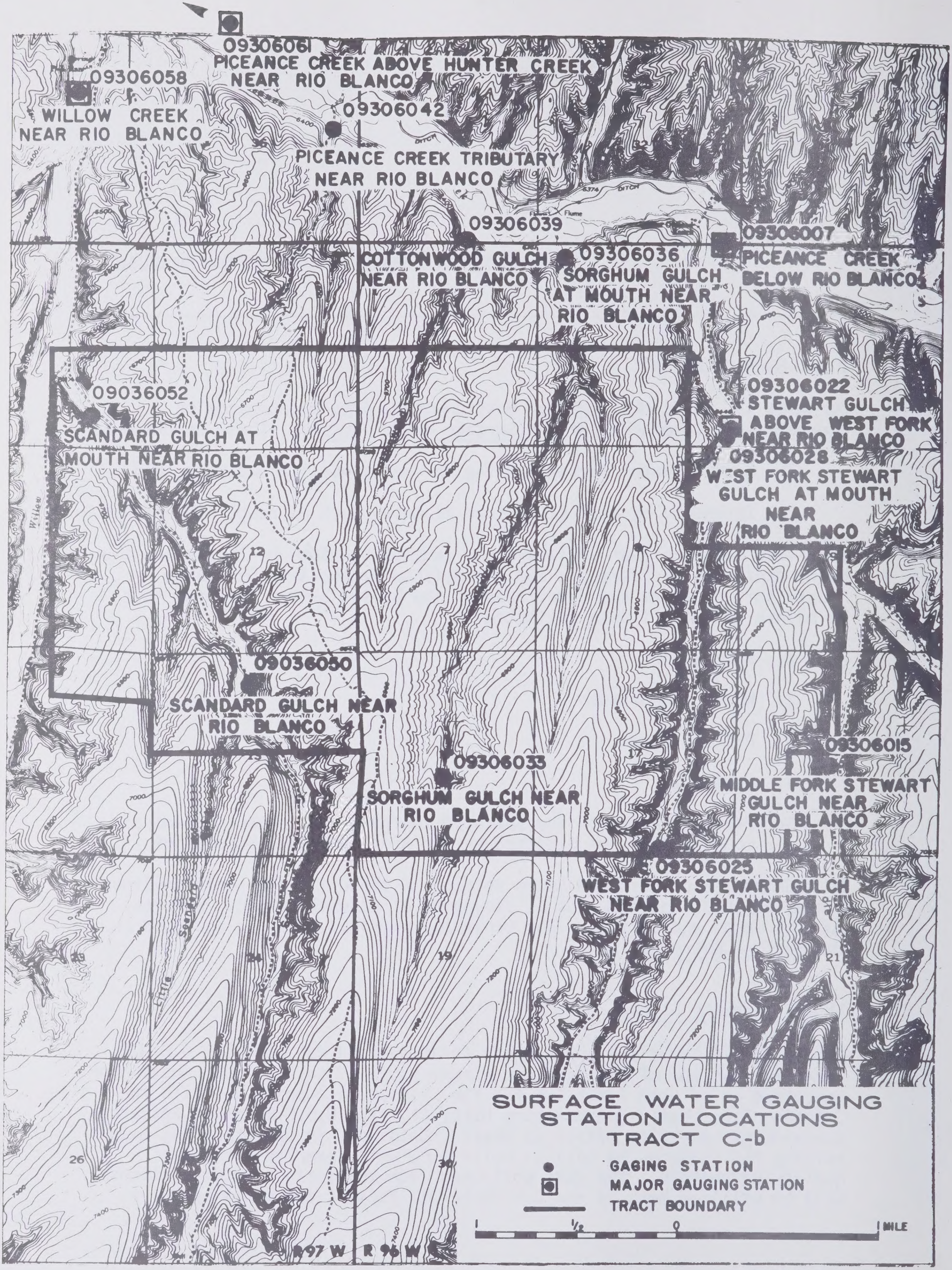
4. Sediment

5. Periodic analyses for selected inorganic and organic chemical constituents, as directed by the Area Oil Shale Supervisor

In addition, the Flora and Fauna section of the Oil Shale Lease Environmental Stipulations requires an inventory of natural surface features, such as seeps and springs. For reporting purposes, this is included in the Surface Water Section.

II A-1 Surface Streams

Figure II A-1 shows the approximate locations and the official U.S.G.S. name designations of the thirteen stream gauging stations which have been installed on or near Tract C-b for the Lessees in cooperation with the Colorado River Water Conservation District. The U.S.G.S. Water Resources Division sub-district office in Meeker, Colorado, is operating and maintaining the stations as well as collecting water samples for water quality parameters. The data collected from the surface water stations will be utilized both by the C-b Shale Oil Project for baseline water



09306061
PICEANCE CREEK ABOVE HUNTER CREEK
NEAR RIO BLANCO
09306058
WILLOW CREEK
NEAR RIO BLANCO
09306042
PICEANCE CREEK TRIBUTARY
NEAR RIO BLANCO
09306039
COTTONWOOD GULCH
NEAR RIO BLANCO
09306036
SORGHUM GULCH
AT MOUTH NEAR
RIO BLANCO
09306007
PICEANCE CREEK
BELOW RIO BLANCO
09036052
SCANDARD GULCH AT
MOUTH NEAR RIO BLANCO
09306022
STEWART GULCH
ABOVE WEST FORK
NEAR RIO BLANCO
09306028
WEST FORK STEWART
GULCH AT MOUTH
NEAR
RIO BLANCO
09036050
SCANDARD GULCH NEAR
RIO BLANCO
09306033
SORGHUM GULCH NEAR
RIO BLANCO
09306015
MIDDLE FORK STEWART
GULCH NEAR
RIO BLANCO
09306025
WEST FORK STEWART GULCH
NEAR RIO BLANCO
R 97 W
R 96 W
SURFACE WATER GAUGING
STATION LOCATIONS
TRACT C-b
GAGING STATION
MAJOR GAUGING STATION
TRACT BOUNDARY
1/2
0
1 MILE

FIGURE II A-1

quality documentation and by the U.S.G.S. in their evaluation of regional water resources.

Nine of the thirteen gauging stations are located on ephemeral streams which flow only when a precipitation event occurs. The other four stations are located on perennial drainages, and are designated as major gauging stations for complete data collection:

1. U.S.G.S. No. 09306022 on Stewart Gulch above West Fork

2. U.S.G.S. No. 09306058 on Willow Creek near Piceance Creek

3. U.S.G.S. No. 09306007 on Piceance Creek upstream of Tract C-b

4. U.S.G.S. No. 09306061 on Piceance Creek downstream of Tract C-b

Table II A-1 is a summary of the instrumentation installed in the thirteen surface water gauging stations.

Table II A-2 outlines the required water quality analytical program.

Tables II A-3 and II A-4 are examples of the data collected to date and included in the Quarterly Report #1 submitted to the Area Oil Shale Supervisor. The Quarterly Report #1 also includes the U.S.G.S. and other laboratory water quality analyses report sheets.

In August, 1974, the Area Oil Shale Supervisor clarified the requirements concerning storage-type rain gauges. The U.S.G.S. Water Resources Division commenced installation of the required rain gauges during the fall of 1974. In addition to these gauges, precipitation data are being recorded at the five air quality stations on or near the Tract.

After initial monitoring, the results of the water quality data collection program will be evaluated. It is expected that the frequency of analysis for some of the constituents may be adjusted based upon the initial data.

Although surface water data collection in the vicinity of Tract C-b has only been completed for part of the first year, most of the drainages remained dry throughout the summer and fall of 1974 after the spring runoff.

TABLE II A-1

SURFACE WATER GAUGING STATIONS INSTRUMENTATION

U.S.G.S. STATION NO.	U.S.G.S. STATION DESCRIPTION	Streamflow Recorders	Sediment Samplers	Temperature & Specific Conductivity Recorders	4-Parameter Recorders (+)	Turbidity Recorders
(*) 09306007	Piceance Creek below Rio Blanco	x	x		x	x
(*) 09306015	Middle Fork Stewart Gulch nr Rio Blanco	x	x	x		
09306022	Stewart Gulch at West Fork nr Rio Blanco	x	x		x	
09306025	West Fork Stewart Gulch nr Rio Blanco	x	x	x		
09306028	West Fork Stewart Gulch at mouth near Rio Blanco	x	x	x		
09306033	Sorghum Gulch nr Rio Blanco	x	x	x		
09306036	Sorghum Gulch at mouth nr Rio Blanco	x	x	x		
09306039	Cottonwood Gulch nr Rio Blanco	x	x	x		
09306042	Piceance Creek Tributary nr Rio Blanco	x	x	x		
09306050	Scandard Gulch nr Rio Blanco	x	x	x		
09306052	Scandard Gulch at mouth nr Rio Blanco	x	x	x		
(*) 09306058	Willow Creek nr Rio Blanco	x	x		x	
(*) 09306061	Piceance Creek at Hunter Creek nr Rio Blanco	x	x		x	x

(*) - Major Gauging Station

(+) - Includes pH, Dissolved Oxygen, Temperature, and Specific Conductivity

Storage-type rain gauges are also installed at Stations 09306015, 09306022, 09306050, and 09306058.

TABLE II A-2

SURFACE WATER QUALITY ANALYTICAL PROGRAM REQUIREMENTS

	Semi-Monthly	Quarterly	Continuous	Continuous When Possible
1. Ammonia	x			
2. Arsenic	x			
3. Barium	x			
4. Bicarbonate	x			
5. Boron	x			
6. Cadmium	x			
7. Calcium	x			
8. Carbonate	x			
9. Chloride	x			
10. Chromium	x			
11. COD		x(M)		
12. Coliform, Total & Fecal		x(M)		
13. Color	x			
14. Conductivity, Specific			x(M)	x(0)
15. Copper	x			
16. Cyanide	x			
17. Dissolved Oxygen	x		x(M)	
18. Fluoride	x			
19. Gross Alpha*		x(M)		
20. Gross Beta*		x(M)		
21. Iron	x			
22. Kjeldahl Nitrogen	x			
23. Lead	x			
24. Lithium	x			
25. Magnesium	x			
26. Manganese	x			
27. Mercury	x			
28. Nitrate	x			
29. Nitrite	x			
30. Odor	x			
31. Oil & Grease	x			
32. Ortho-Phosphate	x			
33. Pesticides		x(M)		
34. pH	x		x(M)	
35. Potassium	x			
36. Selenium	x			
37. Silica	x			
38. Sodium	x			
39. Solids, Dissolved	x			
40. Solids, Suspended (sediment)			x(M)	x(0)
41. Sulfate	x			
42. Sulfide	x			
43. Turbidity	x		x(PC)	
44. Zinc		x(M)		
45. Complete element scan for all trace elements		x(M)		
46. Total Organic Carbon (TOC)		x(M)		
If TOC > 10 mg/liter, then				
Dissolved Organic Carbon				
Suspended Organic Carbon				
Phenols				
Polycyclic Aromatics				
Sulfur (acid extraction)				
Nitrogen (base extraction)				
47. Stream Flow (discharge)			x(M)	x(0)
48. Water Temperature			x(M)	x(0)

* Depending on count, thorium 230, radium 226, and natural uranium may be required
(M) Major Gauging Stations Only.
(0) All Gauging Stations Except Major Stations.
(PC) Piceance Creek Gauging Stations Only.

TABLE II A-3
Piceance Creek Below Rio Blanco, CO.
U.S.G.S. No. 09306007
April - August, 1974

	4/23	5/3	5/17	5/22	5/31	6/14	6/21	6/26	7/2	7/11	7/20	8/3	8/10	8/31
(*)1. Alkalinity (mg/l)	374	358	423	491	492	476	472	481	506	481	362	488	408	
(*)2. Aluminum (ug/l)				60										
3. Aromatics, Polycyclic (ug/l)														
4. Arsenic (ug/l)			2	1	2	1	3	2	5	4	3	2	3	3
5. Barium (ug/l)				130	200	200	0	< 100	< 100	< 100	0	0	0	100
(*)6. Beryllium (ug/l)				< 6										
7. Bicarbonate (ug/l)	456	436	516	599	600	580	576	587	617	587	441	595	497	
(*)8. Bismuth (ug/l)				< 11										
9. Boron (ug/l)				200	240	250	260	250	250	280	260	240	200	240
10. Cadmium (ug/l)				0	1	0	1	2	0	1	1	1	< 1	1
11. Carbonate (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	
(*)12. Carbon Dioxide (mg/l)	4.6	4.4	5.2	7.6	4.8	5.9	5.8	4.7	6.2	7.5	11.0	7.6	5.0	
13. Chloride (mg/l)	13	9.7	12	15	17	15	17	16	16	17	16	16	13	15
14. Chromium (ug/l)				< 8										
(*)15. Cobalt (ug/l)				< 15										
16. COD (mg/l)														
17. Coliform, Total & Fecal (CL./100ml)														
18. Color (Pt-Co Scale)														
19. Conductivity, Specific (uur)	977	912	1080	1240	1220	1190	1200	1270	1250	1250	1030	1210	1020	
20. Copper (ug/l)				< 4	4	2	3	9	5	1	12	2	4	3
21. Cyanide (mg/l)														
22. Discharge (CFS)	25	34	12 N	6.6	6.4	6.9 N	7.0	7.3 N	6.4	4.0	14	8.0 N	28 N	8.4
23. Dissolved Oxygen (mg/l)														
24. Fluoride (mg/l)	1.3	.7	.8	.9	.9	1.0	.9	.9	.8	.2	.7	.9	.8	.9
(*)25. Gallium (ug/l)				< 8										
(*)26. Germanium (ug/l)				< 16										
(*)27. Hardness (Ca, Mg) (mg/l)	340	320	380	410	410	400	390	400	420	410	340	390	350	320
(*)28. Hardness, Non-Carbonate (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	
29. Iron (ug/l)	110	40	40	300	30	40	20	40	50	50	150	90	50	70
30. Kjeldahl Nitrogen (mg/l)														
31. Lead (ug/l)				< 16	5	7	8	7	1	4	3	4	2	6
32. Lithium (ug/l)				10	10	10	10	10	0	0	0	0	0	0
33. Magnesium (mg/l)	40	38	47	52	53	52	49	50	56	57	39	48	42	47
34. Manganese (ug/l)	30	10	100	210	140	40	180	200	230	180	140	180	70	50
35. Mercury (ug/l)			.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.8
(*)36. Molybdenum (ug/l)				6										
(*)37. Nickel (ug/l)				< 8										
38. Nitrate (mg/l)														
39. Nitrite (mg/l)	.63	.70	.56	.28	.15	.08	.03	.04	.01	2.5	.47	.15	.69	.12
40. Odor (qualitative)														
41. Oil & Grease (mg/l)														
42. Ortho-Phosphate (mg/l)	.06	.03	.09	.12	.18	.06	.03	.06	.00	1.1	.12	.06	.12	.03
(*)43. Ortho-Phosphorus (mg/l)	.02	.01	.03	.04	.06	.02	.01	.02	.00	.36	.04	.02	.04	.01
44. Pesticides (ug/l)														
45. pH	8.2	8.2	8.2	8.1	8.3	8.2	8.2	8.3	8.2	8.1	7.8	8.1	8.2	6.9
46. Potassium (mg/l)	2.7	3.1	3.4	2.9	4.3	3.7	3.4	4.1	3.5	3.8	5.7	3.9	3.4	4.3
47. Selenium (ug/l)			0	2	1	1	1	0	1	1	0	1	2	1
48. Silica (mg/l)	15	14	17	17	17	15	13	16	14	17	15	18	17	16
(*)49. Silver (ug/l)				< 2										
50. Sodium (mg/l)	96	88	110	140	140	150	140	150	150	160	110	140	110	130
(*)51. Sodium Adsorption Ratio	2.3	2.1	2.5	3.0	3.0	3.3	3.1	3.3	3.2	3.4	2.6	3.1	2.6	3.2
(*)52. Sodium (%)	38	37	38	43	42	45	44	45	44	45	41	44	41	46
53. Solids, Dissolved (mg/l)	625	578	701	792	786	776	764	783	809	829	670	786	674	
54. Solids, Suspended														
(*)55. Strontium (ug/l)				1600										
56. Sulfate (mg/l)	160	140	180	190	180	180	180	180	190	200	190	190	170	150
57. Sulfide (mg/l)														
58. Temperature (°C)	10.0	7.5	9.0	11.0	15.0	19.0	19.0	16.0	10.5	22.0	20.0	13.0	14.0	19.5
(*)59. Tin (ug/l)				< 11										
(*)60. Titanium (ug/l)				< 8										
61. Turbidity (JTU)														
(*)62. Vanadium (ug/l)				< 8										
63. Zinc (ug/l)				10	30	30	40	30	0	10	40	20	30	20
64. Zirconium (ug/l)				< 24										
65. Calcium (mg/l)	69	66	74	77	76	73	76	76	74	72	73	75	69	51
66. Complete Element Scan														
67. Radioactivity														
Gross Alpha (pcl)														
Radium 226*														
Gross Beta														
Thorium 230**														
Uranium **														
68. Total Organic Carbon (TOC)														
If TOC > 10 mg/liter, then														
Nitrogen (Base Extraction)														
Organic Carbon, Dissolved														
Organic Carbon, Suspended														
Phenols														
Sulfur (Acid Extraction)														

(*) Not Required

* Required if Gross Alpha > 4 picocuries per liter (pcl)
** Required if Gross Beta > 100 picocuries per liter (pcl)

N Non-Instantaneous Discharge

TABLE II A-4
Piceance Creek Below Rio Blanco, CO
U.S.G.S. No. 09306007
September, 1974 to Date

	9/12	9/20	9/27	10/4	10/23									
(*)1. Alkalinity (mg/l)		428	420											
(*)2. Aluminum (ug/l)														
3. Aromatics, Polycyclic (ug/l)														
4. Arsenic (ug/l)		2	2											
5. Barium (ug/l)		100	0											
(*)6. Beryllium (ug/l)														
7. Bicarbonate (ug/l)		522	502											
(*)8. Bismuth (ug/l)														
9. Boron (ug/l)		120	160											
10. Cadmium (ug/l)		1	<1											
11. Carbonate (mg/l)														
(*)12. Carbon Dioxide (mg/l)														
13. Chloride (mg/l)		16	13											
14. Chromium (ug/l)														
(*)15. Cobalt (ug/l)														
16. COD (mg/l)														
17. Coliform, Total & Fecal (Cl./100ml)														
18. Color														
19. Conductivity, Specific (umr)		1080	1060											
20. Copper (ug/l)		1	0											
21. Cyanide (mg/l)														
22. Discharge (CFS)		7.1	8.1											
23. Dissolved Oxygen (mg/l)														
24. Fluoride (mg/l)		1.0	1.1											
(*)25. Gallium (ug/l)														
(*)26. Germanium (ug/l)														
(*)27. Hardness (Ca, Mg) (mg/l)		380	340											
(*)28. Hardness, Non-Carbonate (mg/l)		0	0											
29. Iron (ug/l)		30	120											
30. Kjeldahl Nitrogen (mg/l)														
31. Lead (ug/l)		4	2											
32. Lithium (ug/l)		0	0											
33. Magnesium (mg/l)		50	44											
34. Manganese (ug/l)		50	50											
35. Mercury (ug/l)		.0	.1											
(*)36. Molybdenum (ug/l)														
(*)37. Nickel (ug/l)														
38. Nitrate (mg/l)														
39. Nitrite (mg/l)		.23	.21											
40. Odor (qualitative)														
41. Oil & Grease (mg/l)														
42. Ortho-Phosphate (mg/l)		.06	.03											
(*)43. Ortho-Phosphorus (mg/l)		.02	.01											
44. Pesticides (ug/l)														
45. pH														
46. Potassium (mg/l)		4.2	3.2											
47. Selenium (ug/l)		1	1											
48. Silica (mg/l)		16	16											
(*)49. Silver (ug/l)														
50. Sodium (mg/l)		120	110											
(*)51. Sodium Adsorption Ratio		2.7	2.6											
(*)52. Sodium (%)		40	41											
53. Solids, Dissolved (mg/l)		696	649											
54. Solids, Suspended														
(*)55. Strontium (ug/l)														
56. Sulfate (mg/l)		160	150											
57. Sulfide (mg/l)														
58. Temperature (°C)		8.0	7.0											
(*)59. Tin (ug/l)														
(*)60. Titanium (ug/l)														
61. Turbidity (JTU)														
(*)62. Vanadium (ug/l)														
63. Zinc (ug/l)		20	0											
64. Zirconium (ug/l)														
65. Calcium (mg/l)		70	63											
66. Complete Element Scan														
67. Radioactivity														
Gross Alpha (pcl)														
Radium 226*														
Gross Beta														
Thorium 230**														
Uranium **														
68. Total Organic Carbon (TOC)														
If TOC> 10 mg/liter, then														
Nitrogen (Base Extraction)														
Organic Carbon, Dissolved														
Organic Carbon, Suspended														
Phenols														
Sulfur (Acid Extraction)														

(*) Not Required

* Required if Gross Alpha > 4 picocuries per liter (pcl)
** Required if Gross Beta > 100 picocuries per liter (pcl)

N Non-Instantaneous Discharge

II A-2 Seeps and Springs

As required by the Oil Shale Lease Environmental Stipulations, an inventory of natural surface features, such as seeps and springs, was conducted by field geologists. As depicted on the map, Figure II A-2, no major seeps or springs have been found on Tract C-b.

Although not required, water quality samples were collected from each seep and spring identified near the Tract. Table II A-5 is a tabulation of these data. Laboratory data sheets are included in the Quarterly Report #1.

While the data collected on seeps and springs are quite limited, one preliminary observation can be made. It would appear that water for the springs may not come from the same source. Spring water on the east of the Tract and along Piceance Creek in several instances appears somewhat different from spring water along Willow Creek. Although it is premature to determine the statistical significance of a difference in readings, it is interesting to compare the fluoride content of Springs 1-5 with Springs 6-10 located in the Willow Creek vicinity. It is also noted that both iron and aluminum content are in general somewhat different on either side of the Tract.

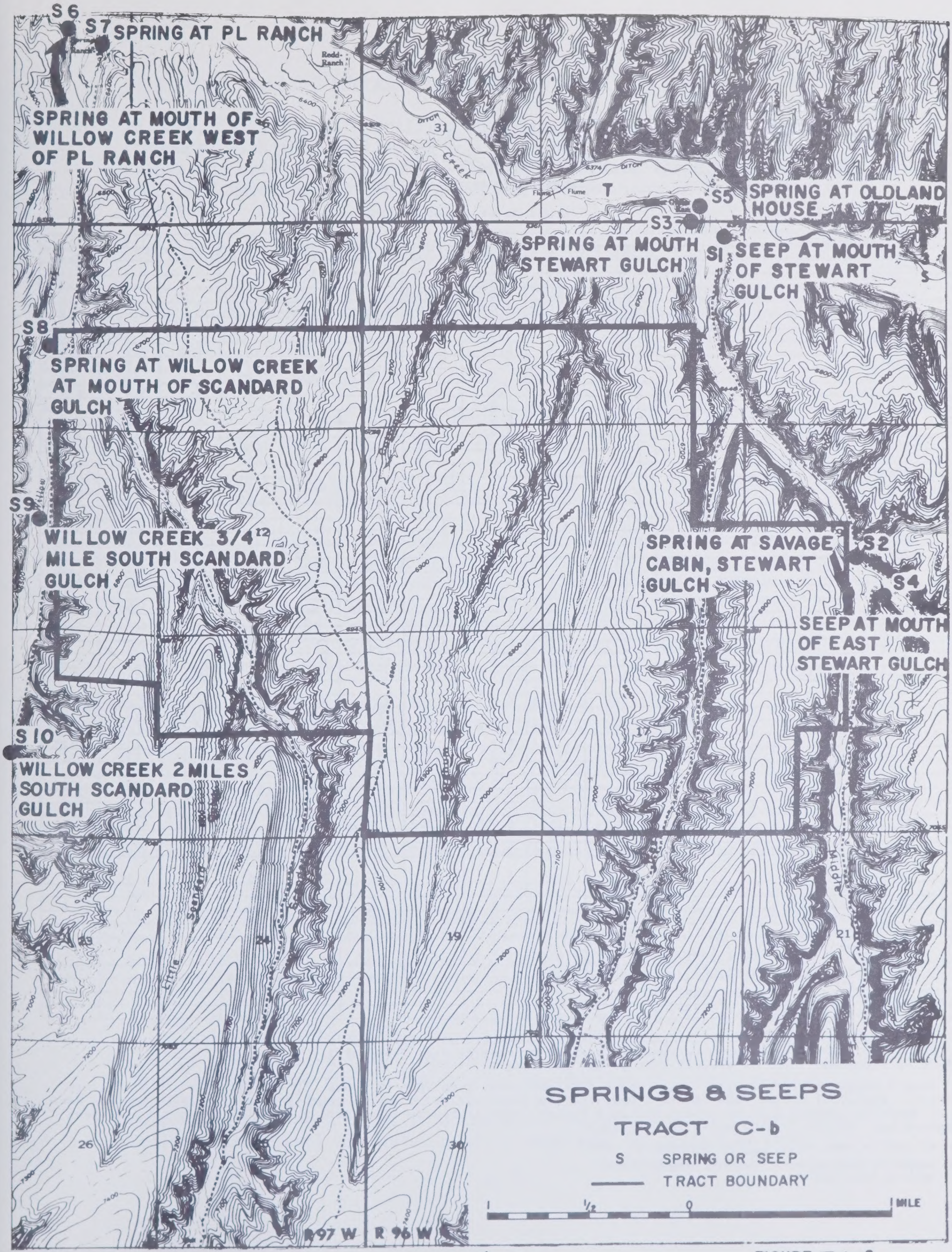

S6
S7 SPRING AT PL RANCH
SPRING AT MOUTH OF WILLOW CREEK WEST OF PL RANCH
S5 SPRING AT OLDLAND HOUSE
S3 SPRING AT MOUTH STEWART GULCH
S1 SEEP AT MOUTH OF STEWART GULCH
S8 SPRING AT WILLOW CREEK AT MOUTH OF SCANDARD GULCH
S9 WILLOW CREEK 3/4 MILE SOUTH SCANDARD GULCH
SPRING AT SAVAGE CABIN, STEWART GULCH
S2
S4 SEEP AT MOUTH OF EAST STEWART GULCH
S10 WILLOW CREEK 2 MILES SOUTH SCANDARD GULCH
SPRINGS & SEEPS
TRACT C-b
S SPRING OR SEEP
TRACT BOUNDARY
1 1/2 0 1 MILE
R 97 W R 96 W

FIGURE II A-2

TABLE II A-5

WATER QUALITY ANALYSIS

SEEPS and SPRINGS (a)

Location: (See Map) (unless stated otherwise, all units are mg/l)

	Element Measured	1	2	3	4	5 (b)	6	7	8	9	10
1.	Aluminum	.06	.1	.3	0.1	.1	1.3	2.3	.2	.2	6.1
2.	Ammonia	.1	<.1	<.1	<.1	<.1	<.1	<.1	0.1	0.1	0.1
3.	Arsenic	.003	.004	.003		.002	.03	.004		.002	.002
4.	Barium	.02	.05	.01	.05	.03	.03	0.01	.06	.05	.05
5.	Beryllium	<.005	.002	<.006	.001	<.003	<.007	<.007	<.007	<.003	<.001
6.	Bicarbonate	520	495	520	480	276	560	520	606	516	540
7.	Bismuth	<.005	<.006	<.006	<.007	<.003	<.007	<.007	<.007	<.003	<.001
8.	Boron	1.4	1.2	1.1	1.2	1.4	1.6	1.6	0.2	0.4	0.6
9.	Cadmium	<.005	<.006	<.006	<.007	<.003	<.007	<.007	<.007	<.003	<.001
10.	Calcium	100	82	92	66	93	102	116	143	130	161
11.	Carbonate	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
12.	Cerium	<.005	<.006	<.006	.005	.002	<.007	<.007	.005	.002	.002
13.	Chloride	4.2	4.8	4.8	3.5	4.2	4.	4.	4.0	4.0	0.8
14.	Chrome, Hexavalent	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
15.	Cobalt	0.002	<.006	.004	0.03	.005	0.01	0.002	.02	.05	.002
16.	Conductivity, Specific	1380	1145	1250	1100	1320	1250	1260	1280	1180	1180
17.	Copper	.04	.04	.03	.2	.1	.05	.03	.2	.1	.03
18.	Fluoride	.9	.6	.7	.6	.6	2.1	1.5	1.7	1.5	1.4
19.	Gallium	<.005	<.006	<.006	.006	.002	0.005	0.006	<.007	<.003	<.001
20.	Hardness, Total	484	536	380	548	510	512	512	576	512	516
21.	Hydroxide	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
22.	Iron	1.8	.5	4.0	7.8	2.0	.8	.7	.14	.84	.47
23.	Lead	<.005	.01	.02	.04	.01	.03	.03	<.007	<.003	.02
24.	Lithium	.05		.03	.3	.07	.4	.1	.1	.5	.2
25.	Magnesium	57	81	37	93	67	63	54	53	46	28
26.	Manganese	.2	.02	.04	1.4	.05	.03	.01	.1	.05	.06
27.	Mercury	.001	.001	.002	.001	.0019	.0017	.0003	.0001	.0001	.0014
28.	Molybdenum	<.005	<.006	<.006	.013	0.03	0.01	<.007	.06	.2	.02
29.	Nickel	0.02	.004	.01	.08	0.03	0.01	0.009	.01	.02	.005
30.	Nitrate	8.1	5.4	5.6	6.0	3.9	2.7	2.9	1.1	1.7	.1
31.	pH	7.9	8.0	7.6	7.8	5.3	8.2	8.1	7.9	8.1	7.9
32.	Phosphate, Total	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
33.	Potassium										
34.	Selenium	.005	<.006	<.006	<.007	<.003	<.007	<.007	<.007	<.003	<.001
35.	Silica	12	13	13	13	15	15	16	13	14	13
36.	Silver	<.005	<.006	<.006	<.007	<.003	<.007	<.007	<.007	<.003	<.001
37.	Sodium	200	110	195	90	82	163	147	138	152	125
38.	Solids, Dissolved	1078	875	972	805	679	988	967	995	948	910
39.	Strontium	1	3	2	4	2	5	2	3	1	1
40.	Sulfate	440	335	370	290	400	360	375	350	350	310
41.	Titanium	0.1	.06	.08	0.1	.02	0.3	0.2	0.2	0.2	0.2
42.	Vanadium	0.004	.005	.002	.009	.005	0.004	0.004	.003	.005	.002
43.	Yttrium	<.005	.002	<.006	.003	<.003	<.007	<.007	<.007	<.003	<.001
44.	Zinc	0.04	.1	.3	.1	.2	0.4	.08	.05	.2	.2
45.	Zirconium	<.005	<.006	<.006	<.007	<.003	<.007	<.007	<.007	<.003	<.001
46.	Radioactivity										
	Gross Alpha (pcl)	2.8	2.1	3.4	4	4.6	3.3	1.6	4.2	4.7	1.3
	Radium 226*								0.3	0	
	Gross Beta (pcl)	0	0	0	0	0	0	0	0	0	0
	Thorium 230**										
	Uranium**										
47.	Total Organic Carbon (TOC)	6	3	4	3	3	3	6	3	3	6
	Dissolved Organic Carbon***										
	Suspended Organic Carbon***										
	Phenols***										
	Sulfate, Acid Extraction***										
	Nitrogen, Base Extraction***										

* To be reported if gross alpha is greater than 4 picocuries per liter (pcl).

** To be reported if gross beta is greater than 100 picocuries per liter (pcl).

*** To be reported if TOC is greater than 10 mg. per liter.

1. Seep @ Mouth Stewart Creek 2. East Stewart Gulch Stream from Seeps @ Mouth 3. Spring at Mouth of Stewart Gulch 4. Spring at Savage Cabin Stewart Gulch 5. Spring @ Oldland House 6. Spring @ Mouth of Willow Creek West of PL Ranch 7. Spring @ PL Ranch 8. Spring @ Willow Creek at Mouth of Scandard 9. Willow Creek 3/4 mile past Scandard 10. Willow Creek 2 miles past Scandard

(a) all samples taken during week of September 30, 1974

(b) suspected sampling error involving stagnant water; will be investigated.

II B CORE DRILLING AND ASSOCIATED GROUND WATER

In June, 1974, the Core Drilling and Associated Ground Water Program commenced with the drilling of core hole SG-10. This section describes the drilling and ground water data compiled through November 30, 1974, and submitted to the Area Oil Shale Supervisor in Quarterly Report #1.

The Oil Shale Lease Environmental Stipulations require:

1. A test well at each proposed or actual mine site with an observation well in each water-bearing zone defined by the test well

2. A pump test for each of the zones

3. An upgradient and two downgradient observation wells for each spent shale disposal site

4. Monitoring of these wells for water level, water temperature, and water quality at six-month intervals.

The Tract C-b Lessees have drilled the test well at the proposed mine site (AT-1) and completed observation wells in the two aquifers or water-bearing zones (above and below the Mahogany mining zone) and in the potential mining zone. Well AT-1C has been completed as a multi-zone well and has been designated as the primary mine site monitoring well. It selectively monitors water in all three zones: upper aquifer, lower aquifer and mining zone.

A pumping test in the upper aquifer commenced on November 30, 1974, and results will be included in the next Quarterly Report. A second phase of the pumping test of AT-1 will be conducted in the lower aquifer and is planned to commence in February, 1975. In addition to the Lease requirements, eight other drill holes were instrumented to record water level response data at distances of 85 to 3236 feet from the test well AT-1. These data will be used in computer simulation and modelling of the aquifers for water management and mine design.

Well SG-18a has been drilled and completed as the monitoring well upgradient of the proposed Sorghum Gulch spent shale disposal area. Wells SG-19 and A-7 have been drilled and completed as the two monitoring wells downgradient of the proposed Sorghum Gulch disposal area. Drilling and ground water data from these wells are included in Quarterly Report #1.

Through November 30, 1974, a total of 7 deep core holes, 8 additional observation wells in the upper aquifer, 13 alluvial observation wells and the pump test well AT-1 had been drilled or were in progress. The data from wells or core holes drilled in addition to Lease requirements will be utilized for mine design purposes. All of the additional core holes have been or will be completed as ground water observation wells. Water level and water quality data will be collected from

these wells on a periodic basis, to supplement the ground water environmental program and used eventually for water management and mine design purposes.

Figure II B-1 shows the locations of all the deep core holes and observation wells completed or in progress as of November 30, 1974.

Table II B-1 summarizes the drilling information included in Quarterly Report #1 for each of the wells.

More detailed discussion of each phase of the Core Drilling and Associated Ground Water Program follows as outlined below:

II B-1	Well Survey Plats
II B-2	Well Completion Data
II B-3	Jetting Tests
II B-4	Drilling Water Production Data
II B-5	Drilling Water Quality Analysis
II B-6	Baseline Water Quality
II B-7	Geophysical Log Data
II B-8	Lithological Logs
II B-9	Core Assay Data
II B-10	Core and Cuttings Trace Element Analysis
II B-11	Rock Mechanics
II B-12	Gas Determination and Analysis

Examples of the data submitted in Quarterly Report #1 are given where appropriate.

II B-1 Well Survey Plats

Well survey plats have been drawn for all well and core holes completed or in progress as of November 30, 1974. Western Engineers of Grand Junction, Colorado, conducted the field surveys and prepared the plats.

Listed below are those wells for which survey plats have been prepared and submitted in Quarterly Report #1:

Aquifer Test Wells	Alluvial Wells
AT-1 (pump test well)	A-1
AT-1a	A-2
AT-1a1	A-3
AT-1b	A-4
AT-1c	A-5
AT-1d	A-6
	A-7
	A-8
	A-9
	A-10
	A-11
	A-12
	A-13

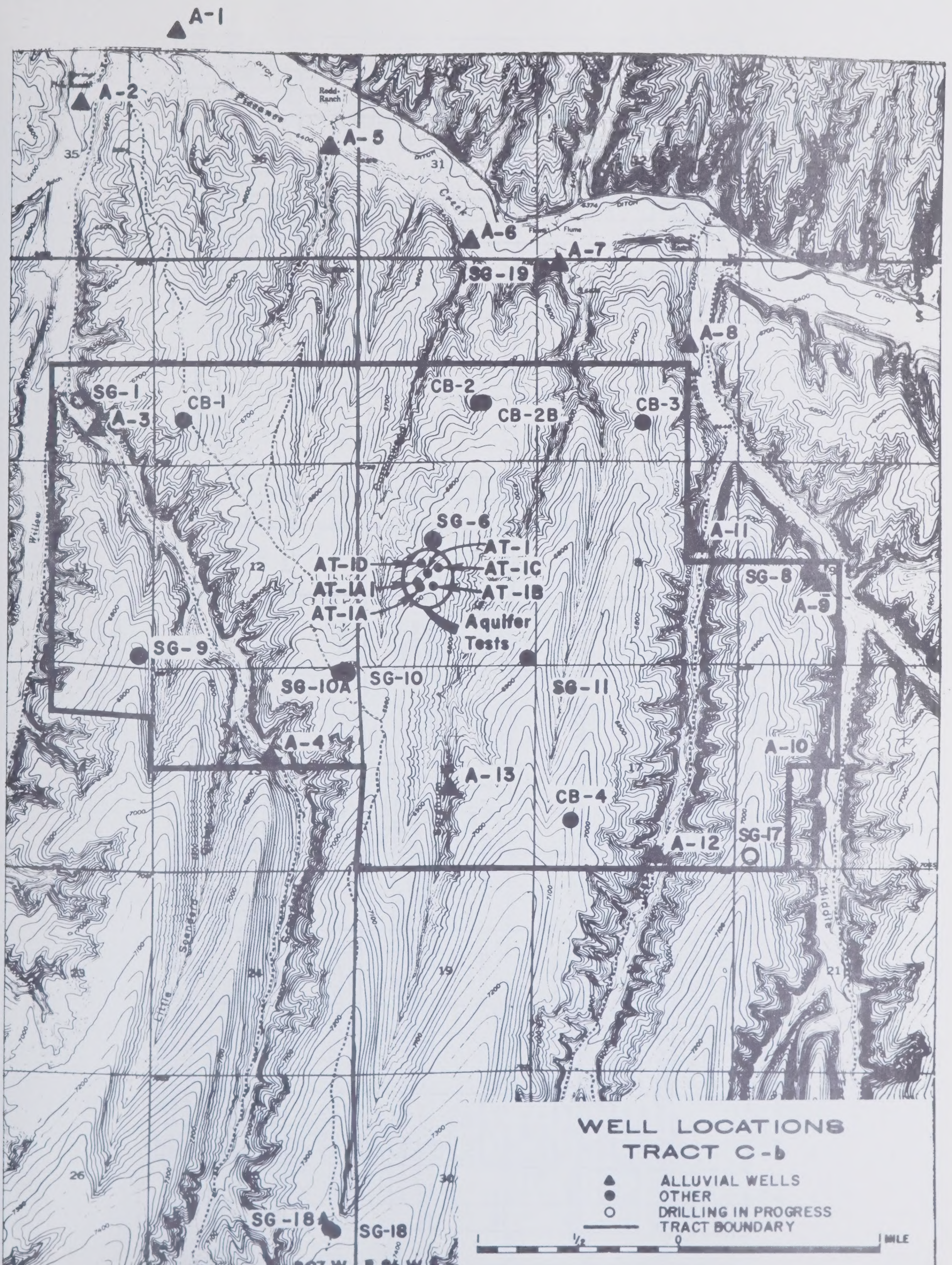

WELL LOCATIONS
TRACT C-b
ALLUVIAL WELLS
OTHER
DRILLING IN PROGRESS
TRACT BOUNDARY
1/2
0
1 MILE
A-1
A-2
A-3
A-4
A-5
A-6
A-7
A-8
A-9
A-10
A-11
A-12
A-13
SG-1
SG-6
SG-8
SG-9
SG-10
SG-10A
SG-11
SG-17
SG-18
SG-18A
SG-19
CB-1
CB-2
CB-2B
CB-3
CB-4
AT-1
AT-1A
AT-1A1
AT-1B
AT-1C
AT-1D
Aquifer Tests
Rodd Ranch
Piceance
Creek
Ditch
Flume
Willow
Little
Sorghum
Middle
R 97 W
R 96 W

FIGURE II B-1

TABLE II B-1
Well Summary Table

AQUIFER TEST WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data: Modified Fisher Assay	Assay Data: Al.	Assay Data: Na	Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data: Drilling Log	Gas Data: Bomb Sample	Completion Data	Survey Plat
AT-1	Partially Complete	1 Zone (JT)	Complete To 1338'	Complete (1 Sample)	5 - B, L, FD, ND, & T.	Field	No Core Taken	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	Yes	Yes
AT-1a	Drilling Completed 7/1/74 To 1621' T.D.	4 Zones (JT) 1 Zone (DST)	Complete To 1611'	Complete (4 Samples)	8 - E, V, D, N, C, T', T, (W).	Field	1270' To 1519'	Yes	Yes	Yes		Yes	N.A.	N.A.	Yes	Yes
AT-1al	Drilling Completed 7/10/74 To 1341' T.D.	1 Zone (JT)	Complete To 1320'	N.A.	N.A.	Field	No Core Taken	N.A.	N.A.	N.A	Inc.	N.A.	N.A.	N.A.	Yes	Yes
AT-1b	Drilling Completed 7/20/74 To 1638' T.D.	4 Zones (JT)	Complete To 1630'	N.A.	6 - B, L, FD, ND, T & (TM).	Field	No Core Taken	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	Yes	Yes
AT-1c	Drilling Completed 8/18/74 To 1640' T.D.	4 Zones (JT) 1 Zone (DST)	Complete To 1640' T.D.	Complete (4 Samples)	Inc. (Returned To Schlumber-ger For Correction)	Field	No Core Taken	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	2 Depths	Yes	Yes
AT-1d	Drilling Completed 7/28/74 To 1640' T.D.	4 Zones (JT)	Complete To 1640' T.D.	N.A.	6 - B, L, FD, ND, T & (CBL).	Field	No Core Taken	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	Yes	Yes
SG-6	Drilling Completed 8/22/74 To 2220' T.D.	5 Zones (JT)	Complete To 2220' T.D.	Complete (5 Samples)	Inc. Returned To Schlumber-ger For Correction)	Field	1195' To 2220, T.D	Inc.	Inc.	Inc		Inc.	Yes	4 Depths	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

TABLE II B-1
Well Summary Table (Continued)

AQUIFER TEST WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data: Modified Fisher Assay	Assay Data: Al.	Assay Data: Na	Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data: Drilling Log	Gas Data: Bomb Sample	Completion Data	Survey Plat
SG-10	Drilling Completed 6/29/74 To 2211' T.D.	4 Zones (JT) 1 Zone (DST)	Complete To 2211' T.D.	Complete (4 Samples)	8 - E, V, D, N, C, T', T, (W).	Field	1200' To 2211, T.D.	Yes	Yes	Yes	Inc.	Yes			Yes	Yes
SG-10a	Drilling Completed 7/10/74 To 1333' T.D.	1 Zone (JT)	Complete To 1333' T.D.	N.A.	N.A.	Field	No Core Taken	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Inc.
SG-11	Drilling Completed 9/8/74 To 2826' T.D.	7 Zones (JT)	Complete To 2810'	Complete 25 samples	4 - B, L, T, & (CBL).	Field	750' To 2810, T.D.	Yes	Inc.	Inc.		Inc.	Yes	6 Depths	Yes	Yes
DEEP COREHOLES AND WELLS																
SG-1	Drilling Completed 12/6/74 To 2525' T.D.	Inc.	Inc.	Inc.	Inc.	Field	550' To 2525' T.D.	Inc.	Inc.	Inc.		Inc.	Yes	6 Depths	Inc.	Yes
SG-8	Drilling Completed 11/27/74 To 2608' T.D.	5 Zones (JT)	Complete To 2608' T.D.	Inc.	Inc.	Field	580' To 2608, T.D.	Inc.	Inc.	Inc.	Inc.	Inc.	Yes	6 Depths	Inc.	Yes
SG-9	Drilling Completed 10/23/74 To 2750' T.D.	5 Zones (JT)	Complete To 2750' T.D.	Complete (5 Samples)	Inc. (Returned To Schlumberger For Correction)	Field	1200' To 2750, T.D.	Inc.	Inc.	Inc.	Inc.	Inc.	Yes	8 Depths	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

TABLE II B-1
Well Summary Table (Continued)

DEEP COREHOLES AND WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data			Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data		Completion Data	Survey Plat
								Modified Fisher Assay	Al.	Na.			Drilling Log	Bomb Sample		
SG-17	Drilling in Progress	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.		Inc.	N.A.	9 Depths	Inc.	Yes
SG-18	Drilled & Abandoned 10/13/74 At 1426' T.D.	2 Zones (JT)	Complete To 1426' T.D.	Complete (3 Samples)	4 - B, L, FD, & T.	Field	1380' To 1426,T.D.	Yes	Inc.	Inc.		Inc.	Yes	1 Depth	Yes	Yes
SG-18a	Drilling Completed 10/18/74 To 1330' T.D.	1 Zone (JT)	Complete To 1330' T.D.	Complete (1 Sample)	N.A.	Field	No Core Taken	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	1 Depth	Yes	Inc
SG-19	Drilling Completed 9/28/74 To 980' T.D.	3 Zones (JT)	Complete To 980' T.D.	Complete (4 Samples)	4 - B, L, FD, & T.	Field	930 To 980, T.D.	Yes	Inc.	Inc.		Inc.	Yes	4 Depths	Yes	Yes
SG-20	Drilling in Progress	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.		Inc.	Inc.	Inc.	Inc.	Yes
SG-21	Drilling in Progress	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.	Inc.		Inc.	Inc.	Inc.	Inc.	Yes
Cb-1	Existing Open Corehole To 2103'T.D.	N.A.	N.A.	N.A.	1 - T' & (CBL).	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Yes
Cb-2	Existing Open Corehole To 1469 T.D.	N.A.	N.A.	N.A.	2 - T' & (CBL).	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

TABLE II B-1
Well Summary Table (Continued)

DEEP COREHOLES AND WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data: Modified Fisher Assay	Assay Data: Al.	Assay Data: Na	Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data: Drilling Log	Gas Data: Bomb Sample	Completion Data	Survey Plat
Cb-2b	Drilled & Abandoned 9/20/74 At 1220' T.D.	1 Zone (JT)	Complete To 1220' T.D.	Inc.	N.A.	Field	No Core Taken	N.A.	N.A	N.A		N.A.	Yes	1 Depth	Yes	Inc.
Cb-3	Existing Open Corehole	N.A.	N.A.	N.A.	1 - T'	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Cb-4	Existing Open Corehole To 1470'T.D.	N.A.	N.A.	N.A.	2 - T' & (CBL).	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
ALLUVIAL WELLS																
A-1	Drilling Completed 10/2/74 To 109' T.D.	N.A.	N.A.	Complete	N.A.	Field	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	Yes	Yes
A-2	Drilling Completed 10/4/74 To 82'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-3	Drilling Completed 10/7/74 To 112'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-4	Drilling Completed 10/8/74 To 64'T.D.	"	"	N.A. (Dry Hole)	"	Field	"	"	"	"	"	"	"	"	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

TABLE II B-1
Well Summary Table (Continued)

ALLUVIAL WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data: Modified Fisher Assay	Assay Data: Al.	Assay Data: Na	Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data: Drilling Log	Gas Data: Bomb Sample	Completion Data	Survey Plat
A-5	Drilling Completed 10/3/74 To 86'T.D.	N.A.	N.A.	Complete	N.A.	Field	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Yes
A-6	Drilling Completed 10/10/74 To 60' T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-7	Drilling Completed 9/28/74 To 51'T.D.	"	"	Complete	"	Inc.	"	"	"	"	"	"	"	"	Yes	Yes
A-8	Drilling Completed 10/1/74 To 70'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-9	Drilling Completed 9/23/74 To 57'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-10	Drilling Completed 9/23/74 To 67'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes
A-11	Drilling Completed 9/24/74 To 66'T.D.	"	"	Complete	"	Field	"	"	"	"	"	"	"	"	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

TABLE II B-1
Well Summary Table (Continued)

ALLUVIAL WELLS

Well No.	Status	Drill Stem & Jet Test Data	Drilling Water Production Data	Drilling Water Quality Analysis	Geophysical Log Data*	Lithological Log Data	Cored Intervals	Assay Data: Modified Fisher Assay	Assay Data: Al.	Assay Data: Na	Core & Cuttings Trace Element Analysis	Rock Mechanics Data	Gas Data: Drilling Log	Gas Data: Bomb Sample	Completion Data	Survey Plat
A-12	Drilling Completed 9/24/74 To 81'T.D.	N.A.	N.A.	Complete	N.A.	Field	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Yes
A-13	Drilling Completed 10/8/74 To 14'T.D.	N.A.	N.A.	N.A. (Dry Hole)	N.A.	Field	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes	Yes

* - Legend for interpretation of notation included in Table II B-14 of geophysical log section of data summary.
Inc. - Data collected but analysis incomplete.
N.A. - Not applicable.

Deep Core Holes and Wells	Existing Open Core Holes
SG-1	Cb-1
*SG-6	Cb-2
SG-8	Cb-3
SG-9	Cb-4
*SG-10	
*SG-11	
SG-17	
SG-18	
SG-19	
SG-20	
SG-21	

*Also used as outer observation wells for aquifer pump tests.

Figure II B-2 is the survey plat for core hole SG-11.

II B-2 Well Completion Data

Well completion techniques have been used in the Tract C-b drilling program to enable ground water monitoring of the separate aquifers, above and below the Mahogany mining zone.

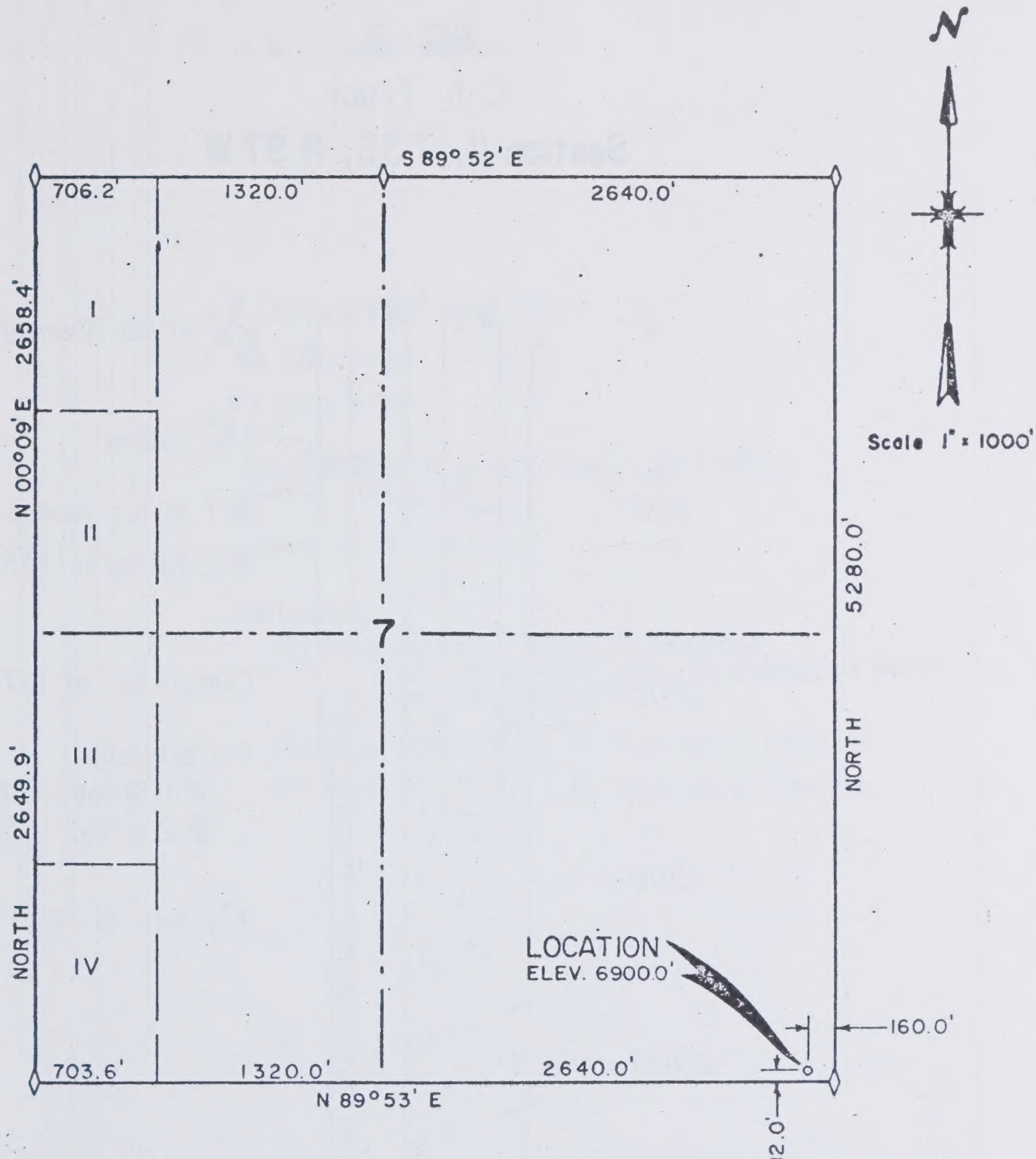
An important consideration in the drilling of wells and core holes on Tract C-b is the usefulness of the holes for ground water monitoring purposes. Therefore, well completion techniques have been developed for use on Tract C-b which allow for selective monitoring of particular water-bearing zones. Either a slotted well casing or multiple strings of small diameter steel tubing have been set in each drill hole. Most core holes are completed with two strings of 2-3/8 inch tubing cemented in the open hole. Each string is then selectively perforated adjacent to the appropriate water-bearing zone, one above the Mahogany zone to monitor the upper aquifer and one below the Mahogany zone to monitor the lower aquifer. This technique provides water quality and water level information from both horizons at the same well location. The drill holes used as observation wells for the aquifer pumping test, were normally completed with three strings; one above the Mahogany zone, one in the Mahogany zone, and one below. This allows for collection of water samples and water level information from all three zones. Also, water level depths can be simultaneously recorded from all three zones during the pumping test. Analysis of the water level data will indicate the degree of any intercommunication between upper and lower aquifers, if any. An illustration of the well completion types discussed above is shown in Figures II B-3 and II B-4.

Well completion data have been prepared and summarized for most of the wells completed prior to November 30, 1974. Table II B-2 lists the wells for which completion data have been submitted in Quarterly Report #1.

FIGURE II B-2

CORE HOLE LOCATION

12.0 FT. N.S.L. – 160.0 FT. W.E.L.
SECTION 7, T 3 S, R 96 W, 6TH P.M.



NOTE – Elevation referred to U.S.G.S. Datum.

I, Clarence J. Bielak do hereby certify that this plat was plotted from notes of a field survey made under my direct responsibility, supervision and checking on Apr. 3, 1974.

Clarence J. Bielak
Registered Land Surveyor

WESTERN ENGINEERS, INC.
CORE HOLE LOCATION
ATLANTIC RICHFIELD COMPANY
SG – 11
RIO BLANCO COUNTY, COLORADO
SURVEYED C.J.B. DRAWN R.W.Q.
GRAND JUNCTION, COLO. 4/8/74

WELL COMPLETION DIAGRAM

SG - 9
C-b Tract
Section 11, T3S, R 97 W

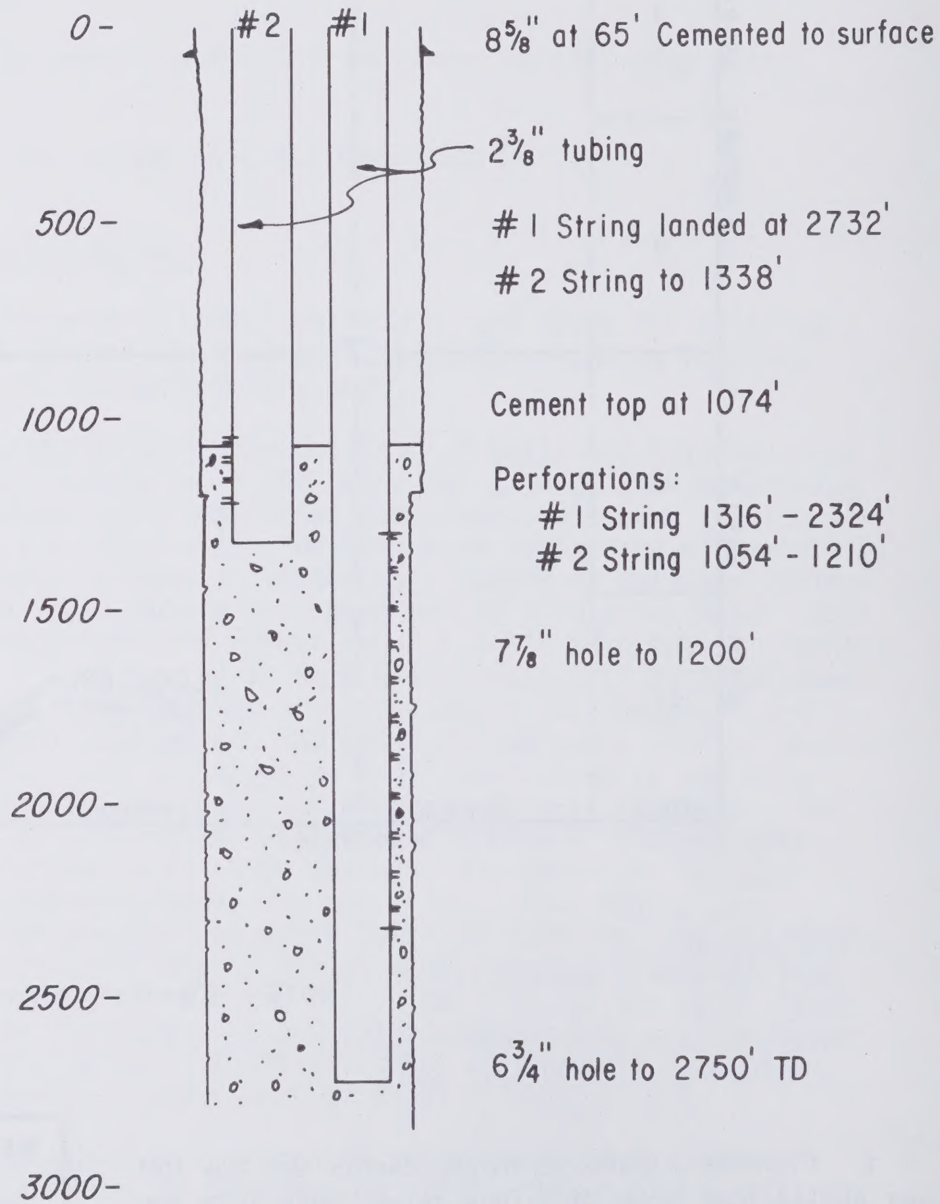


FIGURE IIB-3

SG-11
C-b Tract
Section 7, T3S, R 96W

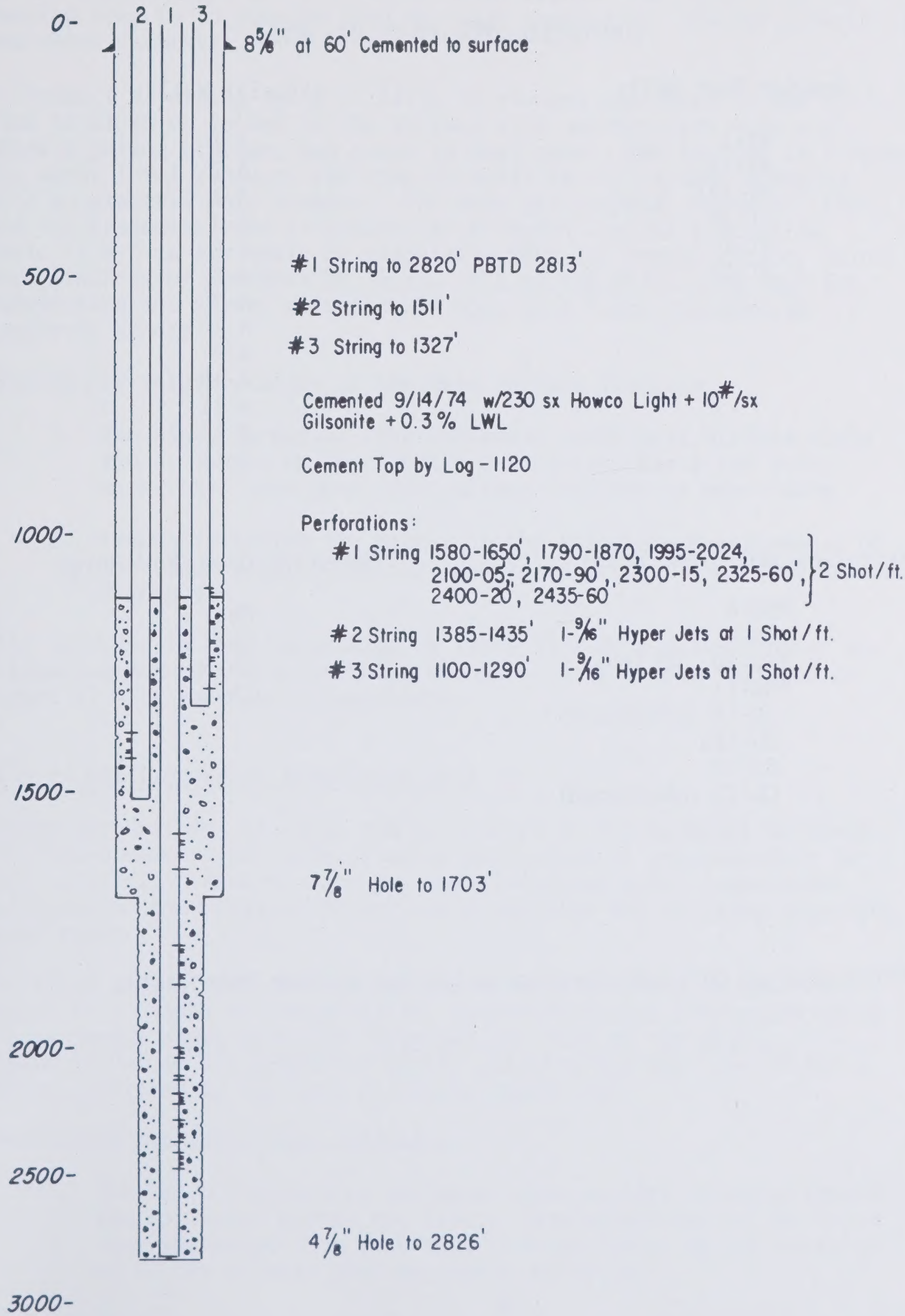


FIGURE IIB-4

TABLE II B-2

COMPLETED CORE HOLES AND WELLS

Aquifer Test Wells	Alluvial Wells
AT-1	A-1
AT-1a	A-2
AT-1a1	A-3
AT-1b	A-4
AT-1c	A-5
AT-1d	A-6
	A-7
	A-8
	A-9
	A-10
	A-11
	A-12
	A-13

Deep Core Holes and Wells	Existing Open Core Holes
*SG-6	Cb-1
SG-9	Cb-2
*SG-10, SG 10-a	Cb-3
*SG-11	Cb-4
SG-18 (abandoned)	
SG-18a	
SG-19	
Cb-2b (abandoned)	

*Also used as outer observation wells for Aquifer Pump Tests.

II B-3 Jetting Tests

Water production jetting tests have been conducted during the drilling of all wells except for shallow alluvial wells. The purpose of the jetting test is to provide data on water production, aquifer permeability and water chemistry.

To conduct a jetting test, drilling is stopped and water in the drill stem is blown or jetted to the surface at a uniform rate with air. After a period of time, two hours in most cases, the jetting is stopped. The water level recovery (or rise in water level) is then measured with an electric well sounder. The data are graphed, depth vs. time, and the transmissivity (a measure of permeability) is calculated. Table II B-3 is a summary of calculated recovery transmissivity values determined as of November 30, 1974. All of the field data used for calculating the values reported in Table II B-3 are included in Quarterly Report #1.

Preliminary interpretation of the data to date indicates:

1. The Uinta formation (the uppermost sandy unit visible along the drainages in the Tract C-b vicinity) has a low transmissivity, less than 1000 gallons/day/foot in most cases

2. Transmissivities are higher in the Parachute Creek member of the Green River Formation, generally greater than 1000 gallons/day/foot.

Also included in this subsection is Table II B-4, a discussion of the calcuation method for determining transmissivity values followed by Figure II B-5, an example calculation.

II B-4 Drilling Water Production Data

During the drilling of wells and core holes on and adjacent to Tract C-b, measurements were made of water production at approximately 30-foot intervals. Records were kept of production water temperature and specific conductivity as well as production and drilling injection water rates.

The field data of all these measurements were included in Quarterly Report #1. Graphs of conductivity, temperature, and discharged water volume versus depth were also prepared for each of the wells. Figure II B-6 is the graph for SG-11, illustrating the type of information submitted to the Area Oil Shale Supervisor.

Preliminary available data indicates:

1. The conductivities in the upper zone aquifer increase toward the northeast across the Tract. Conductivities in the upper zone increased from less than 1000 micromhos in the vicinity of SG-18a to over 2000 micromhos at SG-19;

TABLE II B-3
CALCULATED TRANSMISSIVITY VALUES

Well No.	Jet Test Drill Stem Test No.	Graphical Transmissivity, T (G/D/Ft)	Calculated Transmissivity, T' (G/D/Ft)	Depth To Bottom of Open Interval (Ft)	Drill Stem Test Interval (Ft)	Ground Level Elevation (Ft)	Test Date (1974)
A.T.-1	JT-1	890	----	952		6909	6/29
A.T.-1a	JT-1	384	260	960		6909	6/17
	JT-2	1266	925	1344			6/22
	JT-3	1140	850	1424			6/24
	DST-1	1.42	----	----	1520-1590		7/18
	JT-4	1450	1190	1620			7/1
A.T.-1a1	JT-1	2370	1925	1341		6909	7/10
A.T.-1b	JT-1	64	42.5	960		6909	7/17
	JT-2	1360	883	1340			7/18
	JT-3	2250	1640	1425			7/19
	JT-4	4600	3575	1638			7/29
A.T.-1c	JT-1	1040	640	890		6905	8/13
	JT-2	2415	1900	1355			8/15
	JT-3	2365	1830	1430			8/16
	DST-1	Inc.	----	----	1362-1512		8/17
	JT-4	2940	2370	1640			8/19
A.T.-1d	JT-1	930	593	960		6903	7/23
	JT-2	2090	1750	1355			7/25
	JT-3	2060	1610	1430			7/26
	JT-4	2900	1990	1640			7/29
S.G.-6	JT-1	160	100	910		6888	8/1
	JT-2	1880	1440	1350			8/9
	JT-3	2470	1800	1425			8/10
	JT-4	2750	1930	1547			8/12
	JT-5	3285	2442	2220			8/22
S.G.-10	JT-1	190	200	960		6950	6/11
	JT-2	2975	2170	1336			6/14
	JT-3	3010-4400	2270	1416			6/14
	DST-1	9.6	2.4	----	1480-1600		7/19
	JT-4	7300	4865	2211			6/30
S.G.-10a	JT-1	3100	2050	1333		6950	7/10
S.G.-11	JT-1	1000	730	808		6900	7/26
	JT-2	880	510	868			7/27
	JT-3	5050	3950	1330			8/9
	JT-4	4235	3250	1385			8/9
	JT-5	2360	1690	1490			8/12
	JT-6	5625	3750	2465			8/26
	JT-7	6000	4350	2825			9/1
S.G.-8	JT-1	2485	1709	600		6538	10/26
	JT-2	4040	2463	971			11/5
	JT-3	6025	4950	1013			11/15
	JT-4	7904	5597	2117			11/21
	JT-5	10,100	7110	2608			11/27
S.G.-9	JT-1	230	178	993		6870	9/30
	JT-2	1020	755	1285			10/5
	JT-3	1340	1090	1360			10/5
	JT-4	2890	2125	2460			10/19
	JT-5	2318	1904	2750			10/23
S.G.-18	JT-1	779	50	960		7383	10/1
	JT-2	1800	1400	1426			10/5
S.G.-18a	JT-1	963	----	1330		7383	10/18
S.G.-19	JT-1	7260	4940	466		6382	9/20
	JT-2	22,000	17,000	930			9/23
	JT-3	11,850	9,250	980			9/27
Cb-2b	JT-1	19.5-330	18.3-206	890		6737	8/26

TABLE II B-4

Calculation of Aquifer Transmissivity And Storage Coefficient

The two parameters of primary interest in analyzing the potential yield of aquifers are known as the transmissivity, T, usually expressed in gallons per day per foot, and the storage coefficient, S, which is dimensionless. In intuitive terms, the transmissivity defines the achievable pumping rate from an aquifer and the storage coefficient defines the quantity of water in place. Approximate values for these parameters can be calculated from the results of well pumping tests. A brief explanation of the basis for the calculation procedure follows.

The equations used are known as Jacob's method for the solution of the Theis problem. Theis solved the partial differential equation describing unsteady hydraulic head in an aquifer by imposing the following assumptions and boundary conditions:

1. The well is pumped at a constant rate, Q.
2. The storage coefficient, S, remains constant.
3. Uniform head, h, throughout aquifer at time t = 0.
4. Homogeneous isotropic medium.
5. Infinitesimally small well diameter.
6. Instantaneous removal of water with decline in head.

The mathematical solution, describing h as a function of S, T, and t, is an infinite series. Jacob introduced a simplification by noting that for small (u less than 0.01) values of the lower integral limit, $u = r^2S/4Tt$, the series could be terminated after two terms and the solution becomes:

$$h = \frac{2.30Q}{4\pi T} \log \frac{2.25Tt}{r^2S} \qquad (1)$$

with only t varying, this equation describes a straight line on semi-log paper with slope $2.30Q/4\pi T$. Thus, if one plots observed head as a function of time and measures the change in head, Δh, between any two numbers on the time scale that are one logarithmic unit apart (i.e., $\Delta \log t = 1$, or $t_2 - 10t_1$, regardless of the units of t_1, then:

$$\Delta h = \frac{2.30Q}{4\pi T} \qquad (2)$$

If Q is given in gal/min, h in feet, then for T in gal/day-ft:

$$T = \frac{264Q}{\Delta h} \qquad (3)$$

This equation may be used to analyze data from drawdown or recovery tests with or without an observation well, where the well is pumped at a constant rate. It is also possible to determine S from the same data by noting from equation (1) that for h = 0:

$$1 = \frac{2.25Tt_o}{r2S} \qquad (4)$$

TABLE II B-4 (Continued)

where t_o is the intercept of the straight line on the log t axis at $\Delta h = 0$. With the distance r, between the two wells in feet, T in gal/day-ft, and t_o in minutes:

$$S = \frac{Tt_o}{4800r^2} \qquad (5)$$

The above equations apply directly to the use of two wells, one pumped and one observation.

Where only a single well is available, or time and budget do not permit pump tests, data can be obtained by analyzing the recovery of head in a shutdown well after a period of constant pumping, such as is done in jetting tests. If well head is plotted versus logarithmic time after pump shutdown, a rough value of transmissivity may be obtained from the slope of the line, using equation (3), where Q is the rate at which water was removed during jetting. In the sample calculation shown in Figure II B-5 for well SG-11 at the 1490 ft. level, the solid dots represent head recovery plotted versus time after jetting shutdown. The gain in head over one logarithmic cycle is 12.1 ft. and a transmissivity of 2360 gal/day-ft. is obtained.

The above procedure is mathematically incorrect and should not be used except for a quick-look calculation. The rigorous solution for recovery yields the formula (subject to the same restrictions as equation (3)):

$$\Delta h = \frac{2.30Q}{4\pi T} \log \frac{t}{t'} \qquad (6)$$

Where t is the total time since pumping or jetting was started, and t' is the time since pumping or jetting was stopped. The data sheets in this section include calculated values of t/t' in most cases. In Figure II B-5 these data points are represented by the open triangles. In the units used before, equation (6) becomes:

$$T' = \frac{264Q}{\Delta h}$$

where Δh is now the change in head for one logarithmic cycle of t/t'. In Figure II B-5 the result is T' = 1690 gal/day-ft. It is emphasized that T' should be the more reliable value.

SAMPLE CALCULATION OF AQUIFER TRANSMISSIVITY
SG-11

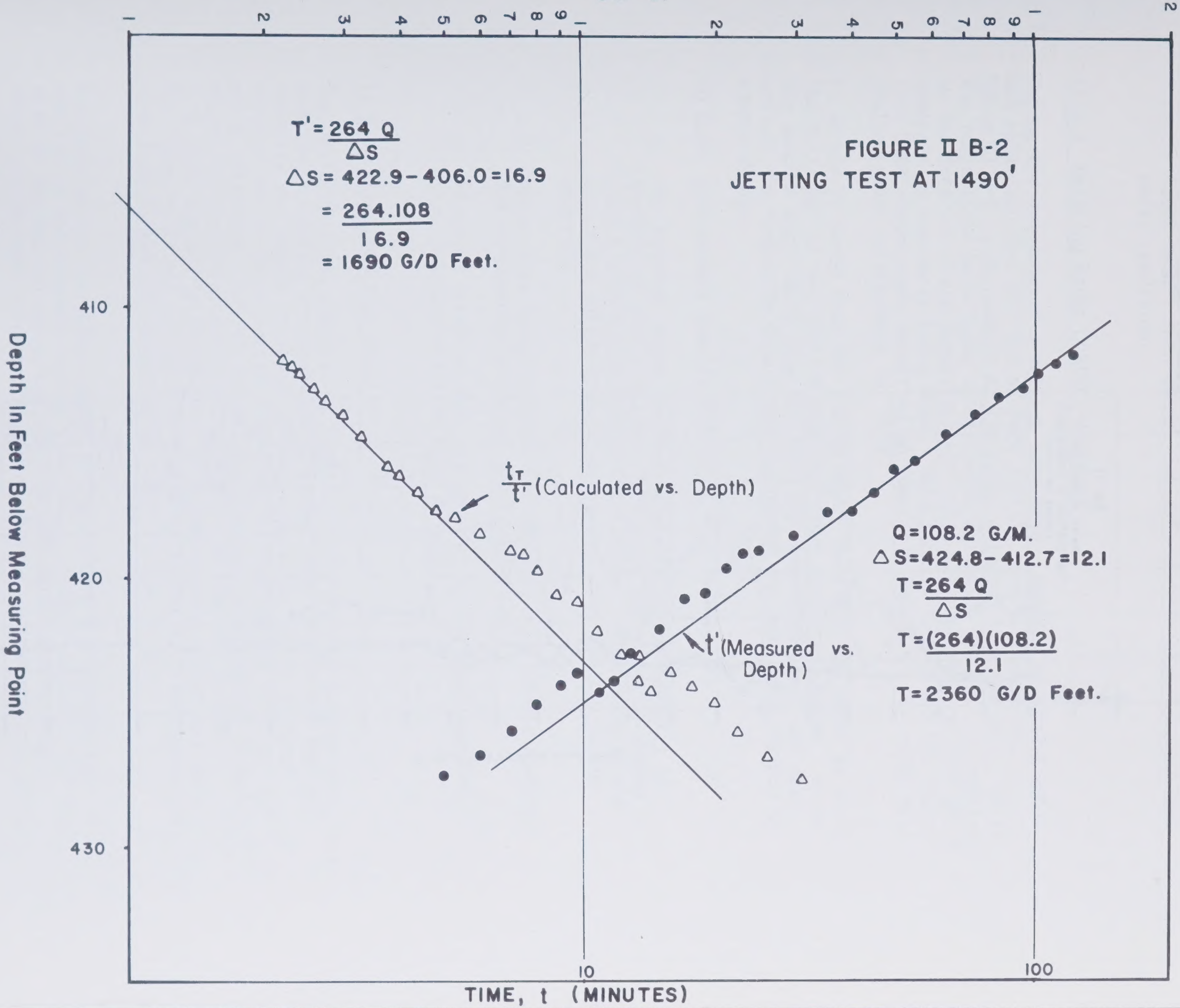


FIGURE IIB-5

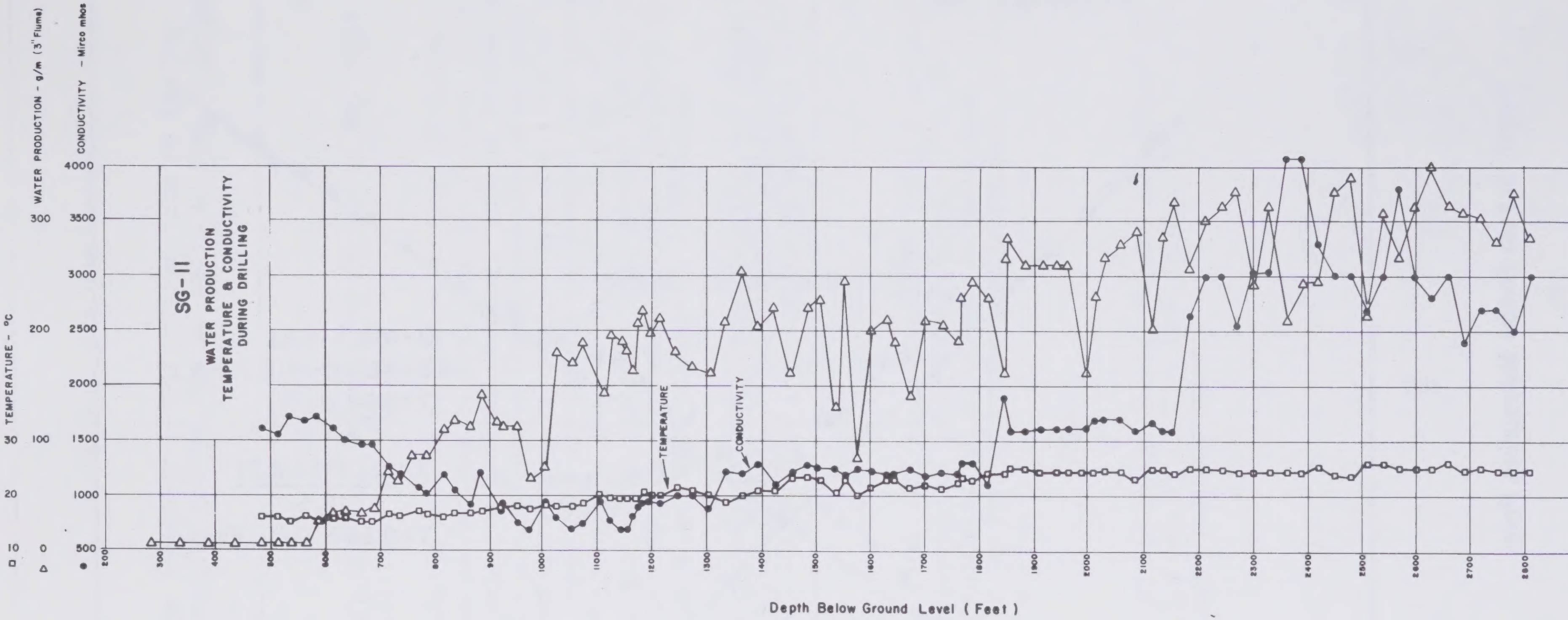

SG-11
WATER PRODUCTION
TEMPERATURE & CONDUCTIVITY
DURING DRILLING
TEMPERATURE - °C
WATER PRODUCTION - g/m (3" Flume)
CONDUCTIVITY - Mirco mhos
TEMPERATURE
CONDUCTIVITY
Depth Below Ground Level (Feet)

FIGURE IIB-6

2. Conductivities within the Uinta formation and the Parachute Creek member show changes which suggest a highly stratified water condition.

II B-5 Drilling Water Quality Analysis

During the drilling of a well or core hole, samples of ground water are collected near the end of each jetting test for analysis. Table II B-5 is an example of the data collected from one well, SG-11. The table lists both those constituents for which analysis is required by the Area Oil Shale Supervisor and those not required, but for which analysis is currently being done. Data summary tables and the laboratory data sheets were submitted in Quarterly Report #1 for every well drilled prior to November 30, 1974.

It should be noted that the sample depth indicates the depth at which the drilling bit was located when the water sample was taken. Since the samples were taken from the drilling water flow line, the data reflect the composite conditions throughout the hole from surface to sample depth.

To date, preliminary results indicate:

1. The interval above the Mahogany zone (upper aquifer) is stratified into a sulfate rich water above, which grades into a sodium bicarbonate water below. Surprisingly, the dissolved solids content is highest near the top of the interval

2. Major ions in water below the Mahogany zone (lower aquifer) are predominantly sodium and bicarbonate

3. Fluoride values within both the upper and lower aquifers vary considerably from hole to hole.

II B-6 Baseline Water Quality

The collection and analysis of baseline water quality samples is required to define pre-development ground water conditions and to identify any trends in water quality with time. Water quality samples are to be collected from required observation wells at six-month intervals. All of the Oil Shale Lease Environmental Stipulations required observation wells (AT-1c, SG-18a, SG-19, and A-7) were sampled by November 1, 1974. Available analytical data for these wells are included in Quarterly Report #1. The analytical data from SG-18a are presented in Table II B-6.

For many wells, the water sample collected from the jetting test at the top of the Mahogany mining zone (base of upper aquifer) has been used as the initial upper aquifer baseline water quality sample. Water quality data from drilling are reported in the previous section.

TABLE II B- 5

WATER QUALITY ANALYSIS
DRILLING WATER

Well Number: SG-11 (Unless otherwise stated, all units are mg/l)
Location: 12'FSL&160'FEL Sec. 7 T3SR96W Elevation: 6900 Grd.

	Element Measured	Depth at Which Sample Taken (ft.) 808	868	1330	1385	2465	2825
1.	Aluminum	0.6	2.	2.	.6	.03	.02
2.	Ammonia	–	0.9	<.1	0.3		.2
3.	Arsenic	.03	.02	.03	.02	.01	.02
4.	Barium	.04	.04	.03	.02	.2	0.06
5.	Beryllium	<.001	<0.1	<.009	<.001	<.002	.001
6.	Bicarbonate	441	383	620	564	1036	973
7.	Bismuth	<.001	<.001	<.009	<.009	<.002	<.001
8.	Boron	<.1	<.1	1.0	1.6	0.4	<.1
9.	Cadmium	<.001	<.01	<.009	<.009	<.002	<.001
10.	Calcium	59	33	89	26	18	36
11.	Carbonate	9	8	2	14	26	43
12.	Cerium	<.001	<.001	<.009	<.009	.001	<.001
13.	Chloride	8	6	5	3	101	68
14.	Chrome, Hexavalent	<.01	<.01	<.01	<.01	<.01	<.01
15.	Cobalt	.02	.02	.006	.008	.06	.03
16.	Conductivity, Specific						
17.	Copper	.3	.06	.01	.009	.04	.007
18.	Fluoride	0.4	1.6	4.4	12	14	10
19.	Gallium	.01	<.001	<.009	.008	<.001	<.001
20.	Hardness, Total	350	250	580	140	67	115
21.	Hydroxide	<.1	<.1	<.1	<.1	<.1	<.1
22.	Iron	<.05	<.05	<.05	<.05	<.05	<.05
23.	Lead	<.05	<.05	.04	<.009	0.05	.09
24.	Lithium	.4	.06	.03	.1	<.5	<.001
25.	Magnesium	43	33	78	18	15	28
26.	Manganese	<.05	<.05	.05	<.05	<.05	<.05
27.	Mercury	<.01	<.01	<.01	<.01	<.01	<.01
28.	Molybdenum	0.2	<.001	.2	<.009	<.05	.01
29.	Nickel	.07	.01	.01	.01	0.1	.06
30.	Nitrate	1.7	3.5	<.1	<.1	<.1	<.1
31.	pH	8.4	8.4	8.2	8.5	8.6	8.6
32.	Phosphate, Total	<.1	<.1	<.1	<.1	<.1	<.1
33.	Potassium	0.6	0.8	1.3	1.2	1.5	1.8
34.	Selenium	<.001	<.001	<.009	<.009	<.002	<.001
35.	Silica	24	21	19	11	17	19
(*)36.	Silver	<.001	<.001	<.009	<.009	<.002	
37.	Sodium	165	141	215	211	488	500
38.	Solids, Dissolved	841	634	1150	659	1244	1382
39.	Strontium	7	3	1	0.5	1	1
40.	Sulfate	316	202	433	86	56	199
41.	Titanium	.2	.1	0.1	.04	.2	.07
42.	Vanadium	.01	.003	.007	.003	<.001	<.001
43.	Yttrium	<.001	<.001	.005	<.009	<.001	<.001
44.	Zinc	.06	0.1	.2	.03	.08	<.3
45.	Zirconium	<.001	<.001	<.009	<.009	<.003	.003
46.	Radioactivity						
	Gross Alpha (pcl)						
	Radium 226*						
	Gross Beta (pcl)						
	Thorium 230**						
	Uranium**						
47.	Total Organic Carbon (TOC)						
	If TOC > 10 mg/l then measure						
	Dissolved Organic Carbon						
	Suspended Organic Carbon						
	Phenols	<.005	<.001	<.001	<.001	<.001	<.01
	Sulfate, Acid Extraction						
	Nitrogen, Base Extraction						

(*) Not required
* Required if gross alpha is greater than 4 picocuries per liter (pcl).
** Required if gross beta is greater than 100 picocuries per liter (pcl).

TABLE II B-6

BASELINE WATER QUALITY ANALYSIS
MONITORING WELL

Well Number: 18a, at 1330' T.D.
Location: See fig. II B-1

	DATE SAMPLE TAKEN	11/1/74				
	Element Measured (+)					
1.	Aluminum	0.5				
2.	Ammonia					
3.	Arsenic	.02				
4.	Barium	.03				
5.	Beryllium	<.007				
6.	Bicarbonate	471				
7.	Bismuth	<.007				
8.	Boron	1.4				
9.	Cadmium	<.007				
10.	Calcium	24				
11.	Carbonate	0				
12.	Cerium	<.007				
13.	Chloride	3				
14.	Chrome, Hexavalent					
15.	Cobalt	.001				
16.	Conductivity, Specific					
17.	Copper	.02				
18.	Fluoride	190				
19.	Gallium	<.007				
20.	Hardness, Total					
21.	Hydroxide					
22.	Iron	0.02				
23.	Lead	<.02				
24.	Lithium	.3				
25.	Magnesium	30				
26.	Manganese	0.04				
27.	Mercury	.0024				
28.	Molybdenum	0.03				
29.	Nickel	0.005				
30.	Nitrate	0.22				
31.	pH	8.2				
32.	Phosphate, Total					
33.	Potassium	0.4				
34.	Selenium	<.007				
35.	Silica	23				
(*)36.	Silver					
37.	Sodium	135				
38.	Solids, Dissolved	536				
39.	Strontium	0.3				
40.	Sulfate	84				
41.	Titanium	0.04				
42.	Vanadium	0.001				
43.	Yttrium	0.007				
44.	Zinc	0.03				
45.	Zirconium	<.007				
46.	Radioactivity					
	Gross Alpha (pcl)	8.0				
	Radium 226*	0.1				
	Gross Beta (pcl)	0				
	Thorium 230**					
	Uranium**					
47.	Total Organic Carbon (TOC) If TOC > 10 mg/l then measure	<1				
	Dissolved Organic Carbon					
	Suspended Organic Carbon					
	Phenols					
	Sulfate, Acid Extraction					
	Nitrogen, Base Extraction					

(*) Not required
* Required if gross alpha is greater than 4 picocuries per liter (pcl).
** Required if gross beta is greater than 100 picocuries per liter (pcl).
(+) Unless otherwise stated, all units are mg/l.

II B-7 Geophysical Log Data

Only two types of geophysical logs are required to be run on test holes. They are the sonic log and resistivity log. As of September 12, 1974, the Area Oil Shale Supervisor specified that the resistivity log should be either a standard electric resistivity log or focused electric resistivity log rather than the induction-type log. Table II B-7 shows the individual geophysical logs completed as of November 30, 1974 for each well on Tract C-b (included in Quarterly Report #1).

Resistivity logs are used for the definition of formations, for correlations, and for qualitative and quantitative analysis of formations in terms of fluid saturation and porosity. For most of the wells, a laterolog has been run to satisfy the resistivity log requirement; on others, a Birdwell standard electrical survey was run for the resistivity log (AT-1a and SG-10).

Sonic logging fundamentally involves measuring the time required for a sound wave to travel through a definite length of formation. The sonic log is quite detailed and is a good log for correlation purposes. Birdwell velocity logs (sonic) were run on wells AT-1a and SG-10; on all other wells Schlumberger borehole compensated sonic log-gamma ray logs were run.

Logs run and not required are the gamma ray, neutron density, temperature, micro-seismograph, and caliper logs.

II B-8 Lithologic Logs

The lithologic logs present a description of rock types from the surface rocks encountered in a core hole to total depth. The detail of description varies with depth and operation. Above the "A" Groove, the lithology is described from drill cuttings on approximately ten-foot intervals. Below the "A" Groove, the litholgy is described from cores on about one-foot intervals.

In addition to providing a means for describing lithology, the litholog presents additional required data such as information on structural dip, joints, fractures, and general rock quality data. These data are entered in the lithologic log at the appropriate depth. The log then presents a depth record of rock type and structure.

A field lithologic log has been made on each well drilled prior to November 30, 1974. Listed below are lithologic logs submitted in Quarterly Report #1:

TABLE II B-7

GEOPHYSICAL LOGS

Geophysical Log Type	AT-1	AT-1a	AT-1b	AT-1d	SG-10	SG-11	SG-18	SG-19	Cb-1	Cb-2	Cb-3	Cb-4
Schlumberger:												
B-Borehole Compensated Sonic	X		X	X		X	X	X				
L-Laterolog	X		X	X		X	X	X				
FD-Formation Density	X		X	X			X	X				
ND-Neutron Formation Density	X		X	X								
T-Temperature	X	X	X	X	X	X	X	X				
CBL-Cement Bond Log				(X)		(X)				(X)		(X)
Birdwell:												
V-Velocity, 3-Dimensional		X			X							
E-Electric		X			X							
D-Density		X			X							
N-Nuclear		X			X							
C-Caliper		X			X							
T-Temperature		X			X				X	X	X	X
Welex:												
W-Micro-Seismogram		(X)			(X)							
McCullough:												
TM-Temperature			(X)									

( ) - Field copies only of the geolog are available. Films are not complete for distribution.

Aquifer Test Wells	Alluvial Wells
AT-1 (pump test well)	A-1
AT-1a	A-2
AT-1a1	A-3
AT-1b	A-4
AT-1c	A-5
AT-1d	A-6
	A-8
Deep Core Holes and Wells	A-9
	A-10
SG-1	A-11
SG-6	A-12
SG-8	A-13
SG-9	
SG-10	
SG-10a	
SG-11	
SG-11	
SG-18	
SG-18a	
SG-19	
Cb-2b	

II B-9 Core Assay Data

Assays of core samples are being run for economic and mining information, analyzing for:

1. Shale oil content
2. Sodium
3. Alumina.

The shale oil content is being determined by the Modified Fisher Assay method. Cores are sampled on approximately one-foot intervals and analyzed for kerogen content. Each sample is retorted in the laboratory to yield data on oil content in gallons per ton, water content in gallons per ton, and residue weight in pounds per ton. In addition, gas-plus-loss is calculated for each sample.

Although the Area Oil Shale Supervisor requires analyses of samples for nahcolite (R-4 zone only) and caustic extractable alumina from 2 foot maximum core intervals in the Mahogany and R-4 zones, analyses are generally being made from core samples taken on 1 foot intervals for the entire recovered core. Sodium content is determined by leaching one gram of raw shale in water and measuring the dissolved sodium content by atomic absorption. Alumina is determined by leaching one gram of spent shale with 50 milligrams of 20-gram-per-liter sodium hydroxide solution and measuring the soluble alumina by atomic absorption. Alumina in spent shale is then corrected back to a raw shale basis using the Fisher assay weight loss.

As of November 30, 1974, assays had been run on two wells as shown in Table II B-8 below. These data are included in Quarterly Report #1.

TABLE II B-8

OIL SHALE ASSAY SUMMARY

		ASSAY	
Well No.	Oil Content	Sodium	Alumina
AT-1a	X	X	X
SG-10	X	X	X

II B-10 Core and Cuttings Trace Element Analysis

The Conditions of Approval for the Core Drilling and Associated Ground Water Program require "sampling of drill cuttings or core with subsequent analysis to determine occurrence of arsenic, antimony, boron, cadmium, fluoride, mercury, and selenium" on all core holes until the Area Oil Shale Mining Supervisor has determined that additional sampling and analysis would yield redundant data.

Required laboratory analyses are in progress; no laboratory analytical reports have yet been received by the Lessee. Therefore, these data will be reported in later Quarterly Reports.

II B-11 Rock Mechanics Data

The purpose of the Tract C-b rock mechanics program (geotechnical data) is to provide information for structural design of an oil shale mine. Golder Associates, Inc., mining consultants, are carrying out a comprehensive geotechnical program for use in an eventual Tract C-b commercial mine design. Data obtained by them are analyzed, correlated and then presented in monthly progress reports. When drilling is completed, Golder Associates, Inc. will present all of the data along with a preliminary interpretation. To date, one monthly progress report has been received, reporting on two holes, AT-1a and SG-10. The data obtained by Golder Associates, Inc. can be divided into two parts, a geotechnical log, which is prepared at the drill site, and rock property tests, which are performed in a field lab located on the Tract. Data for AT-1a and SG-10 were submitted in Quarterly Report #1.

Table II B-9 is a summary of the rock mechanics tests run on AT-1a and SG-10. Some difficulty was encountered in obtaining equipment to carry out some of the tests. As a result, neither Direct Shear tests nor the requested triaxial compression tests were run. Direct Shear equipment is now in use, and a special triaxial chamber is being fabricated to accommodate our 3½" diameter core. Selected core samples are being saved from holes currently in progress for later testing.

TABLE II B-9

ROCK MECHANICS TESTS SUMMARY

TEST	NUMBER OF TESTS PER WELL AT-1a	SG-10
BRAZILIAN TENSILE	---	10
COMPRESSION, TRIAXIAL*	---	---
COMPRESSION, UNIAXIAL*	---	---
DENSITY DETERMINATION*	16	16
POINT LOAD	---	30
SCHMIDT HAMMER	---	5
SHEAR, DIRECT*	---	---

*Requested by Area Oil Shale Supervisor

As shown in Table II B-9, several additional tests (Brazilian Tensile, Point Load and Schmidt Hammer) have been run to determine their value as correlating tests. Poor correlation of these results with standard uniaxial tests has resulted in abandoning all except the Brazilian Tensile test which does show some correlation and also provides an indirect measure of tensile strength.

II B-12 Gas Determination and Analysis

The Conditions of Approval for the Core Drilling and Associated Ground Water Program state:

> At least two gas samples must be obtained from each drill hole which penetrates the Mahogany and/or R-4 zones; each sample will be analyzed for methane (CH_4).

The initial plan was to obtain continuous gas sampling on every hole with a Baroid Gas Chromatograph. However, on the first hole, SG-10, severe instrument problems were experienced resulting in complete failure of gas sampling for that hole. Because of this experience, the Baroid continuous analyzer was supplemented on all succeeding holes with periodic bomb samples which were went to a laboratory for analysis.

Because of the close proximity of the cluster of wells in the aquifer test pattern, one "representative" well (AT-1c) was selected and gas sampling was done on that well only. All of the core holes were gas sampled (with the exception of SG-10 as noted above), but none of the shallow alluvial wells were gas sampled since they did not penetrate the Mahogany or R-4 zones.

Included in Quarterly Report #1 is the complete summary of all gas bomb samples and the Baroid gas plots compiled as of November 30, 1974. Excerpted from that report and included in this section as example of the available data are copies of both gas bomb samples (Table II B-10) and Bariod gas plots (Figure II B-7) for SG-11. These data should be used in a qualitative sense only. The numbers reported here are meaningless in a quantitative sense because of unknown factors such as: (1) how much gas was coming up the hole, it is mixed with an unknown amount of circulating drilling air, (2) what depth is the gas being released from; only gas near the mining zone may be of practical consequence, (3) how is the gas contained underground? With regard to this last point, the gas could be (A) in solution in the groundwater, (B) contained in open fractures and joints and trapped there by the groundwater, or (C) actually trapped there by the pore spaces. In the event of (A) or (B) above, it is quite probable that a dewatering program could also degas the interval to be mined.

Through the use of down-hole packer tests and the use of a gas separator in the aquifer pump test, a more definitive program is being planned to get better quantitative measurements and conclusions with regard to underground gas.

TABLE II B-10

ANALYSIS OF GAS SAMPLES FROM TRACT C-b

Sorghum Gulch Core Hole SG-11

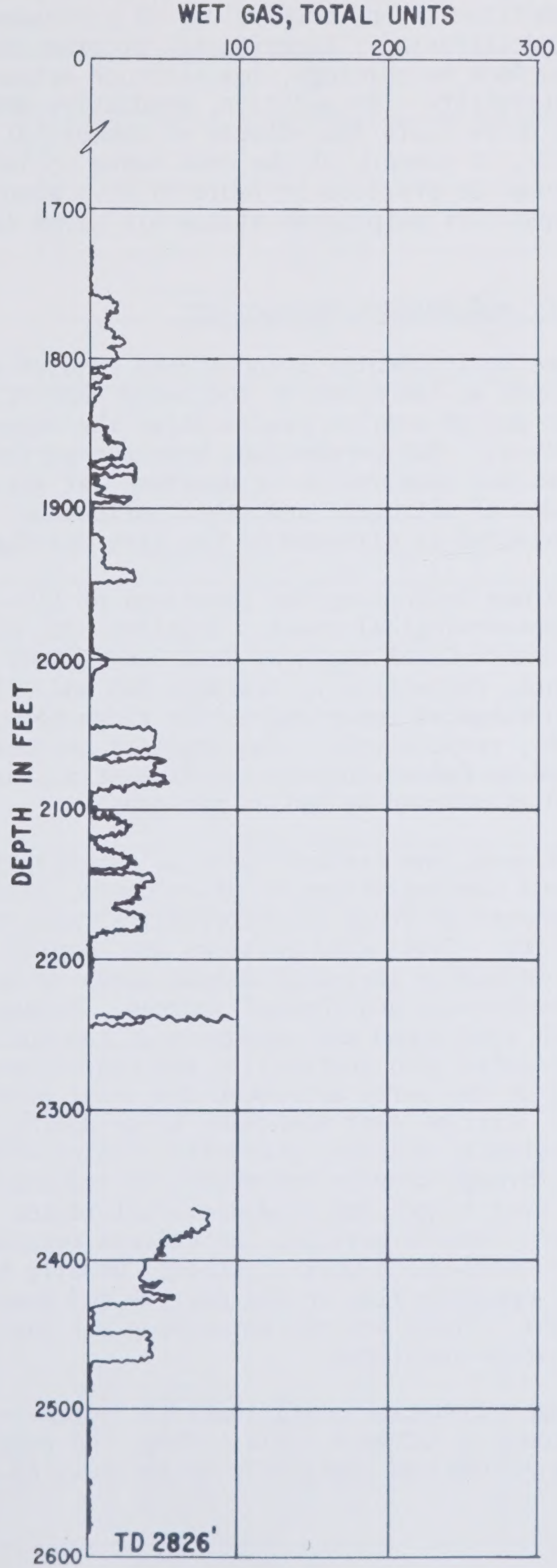
September - November 1974

Core Hole	Date (1974)	Depth (ft)	Methane (mole %)	Ethane (Vppm)	Ethylene (Vppm)	Balance
SG-11*	8/9	1353	(1)	(1)	---	Air
	8/10	1385	0.3	---	---	Air
	8/21	2048	1.1	---	---	Air
	8/21	2085	1.5	46	---	Air
	8/22	2143	1.2	35	---	Air
	9/1	2820	1.8	---	---	Air

*No H_2, CO, CO_2, H_2S or higher hydrocarbons were found in any of the samples; data should only be used as a qualitative analysis (see page 44).

(1) No sample obtained; bomb still under vacuum.

Figure II B-7
BAROID GAS PLOT
SG-11



II C AIR QUALITY

The Tract C-b Air Quality Program is concerned with both measurements of atmospheric constituents and meteorological processes which affect their transport and diffusion. Experimental program areas include air quality and surface meteorology, low-altitude meteorology, upper air studies and visibility. In addition, predictive modeling studies will be conducted to evaluate the effects of commercial operations on ambient air quality. A summary of the data being collected in the experimental programs is provided in Table II C-1; associated sampling and reporting frequencies andprogram status are given in Table II C-2.

II C-1 Air Quality and Surface Meteorology

The Oil Shale Lease Environmental Stipulations require monitoring of air quality data over at least 90% of the Lease year at four stations, one of which is at (or as near as practicable) the expected point of maximum concentrations. Sulfur dioxide, hydrogen sulfide, and suspended particulates are required to be monitored at all stations. Hydrocarbons, oxides of nitrogen "and other pollutants" are also required to be monitored as directed by the Area Oil Shale Supervisor.

Figure II C-1 is a map indicating the locations of five air quality trailers and the meteorological tower. Trailers 020, 021, and 022 are located in the Piceance Creek basin at Redd Ranch, Rock School and the Gerald Oldland Ranch, respectively; trailers 023 and 024 are on the Tract at the meteorological tower and on the ridge between Cottonwood and Sorghum Gulches, respectively. The trailers and meteorological tower were designed by Radian Corporation of Austin, Texas and are being operated and maintained by Radian personnel.

As previously mentioned, one trailer (024) is located at near the point of estimated maximum concentrations as practicable, recognizing that such point is dependent on stack characteristics, wind conditions and atmospheric stability. These wind patterns are complex. Surface winds are subject to highly irregular motion known as turbulence which arises from both mechanical and thermal sources. Mechanical turbulance increases with both wind speed and roughness of the surface. Thermal turbulence is associated with instability and convective activity and is most pronounced in the early afternoon and least pronounced at night and early morning. Airflow over mountains is guided by friction and blocking into topographic drainage channels. Eddies often form where strong winds flow through canyons and mouths of tributaries and on the lee sides of flow over ridges and saddles. Differences in air heating over mountain slopes, canyon bottoms, and valleys results in different but related wind systems which work together; usually they combine in upvalley, upslope, upcanyon flow in the daytime and downflow (or "drainage") at night. These are the meteorological phenomena which led to the selected station locations.

Trailers 020 through 023 became operational in September, 1974; trailer 024 became operational in October, 1974. Thus, the required air quality monitoring system was completely operational as of November 1,

TABLE II C-1

AIR QUALITY & METEOROLOGY DATA DESCRIPTION

Symbols represent sampling frequency on next table

Category & Location \ Measurement	SO_2	H_2S	Particulates	Total Hydrocarbons	Methane (CH_4)	Non-CH_4 H.C.	Ozone	NO_x	NO	NO_2	CO	Wind Speed	Wind Direction	Relative Humidity	Air Temperature	Precipitation	Barometric Pressure	Solar Radiation	Temperature Difference	Acoustic Echo	Visibility
Air Quality & Surface Meteorology																					
Trailer 020	X	X	O	Y	Y	Y	X	X	X	X	Y	X	X	X	X	X		X			
021	X	X	O									X	X	X	X	X					
022	X	X	O									X	X	X	X	X					
023	X	X	O	Y	Y	Y	X	X	X	X	Y	X	X	X	X	X		X			
024	X	X	O									X	X	X	X	X					
Low Altitude Meteorology																					
@ Met. Tower																					
Ground Level																	+				
8 - Ft.												X	X	X	X						
30 - Ft.												X	X	X	X				1,2		
100 - Ft.												X	X	X	X				1		
200 - Ft.												X	X	X	X				2		
Upper Air Studies																					
@ Met. Tower 200 - 6000 Ft.												*	*		*						
Temperature Inversions																					
@ Met. Tower																				&	
Visibility																					
Proposed @ Hunter Creek																					#

TABLE II C- 2

AIR QUALITY & METEOROLOGY SAMPLING FREQUENCY
MIN. AVERAGING TIMES & STATUS

Symbols appear on previous table

Symbol	Sampling Frequency	Min. Average Time or Report Frequency	Description	Status
X	1/sec	5 min. average	AQ & Low Alt. Met.	Operational in Sept. except for Trailer 024
Y	5 min. avg.	5 min. average		
0	1/24 hr. span	Daily Weekly Quarterly Quarterly Quarterly	Particulates Trace Elem. Composites Part. size distribution Gross radioactivity Volatile metals	Operational as of October Operational
1	1/sec	5 min. average	Temp. difference between 30'and 100' height on met. tower	Operational
2	1/sec	5 min. average	Temp. difference between 30'and 200' height on met. tower	Operational
+	1/sec	Daily max. and min. and times	Barometric Pressure	Operational
*	at least 2/day for 15 day/ quarter	same	High Alt. Meteorology Temp. & Wind Profiles to 6000 Ft.	Operational
&	1/(14-sec)	Onset & Extent of Inversions	Acoustic Echo (for Temp. Inversions)	Operational as of 2 January
#	open	open	Visibility	Not Contracted

FIGURE II C-1 AIR QUALITY & METEOROLOGICAL STATION LOCATIONS

1974. Consultant data reports (Radian Corporation) for air quality and low altitude meteorology have been furnished through September, 1974, and are included in Quarterly Report #1; subsequent data will be presented in later Quarterly Reports.

Table II C-3 is a summary of the air quality data for one of the trailers (020). Similar tables are included in Quarterly Report #1 for all of the monitoring trailers. Some additional comments, however, are necessary. To insure statistical significance, and to reduce the possibility of introducing a bias in the presentation, monthly averages are computed only when at least 50% of the samples are present. Included in these tables are the maximum sliding averages of various pollutants for different averaging times. These averaging times are chosen to allow comparison to ambient air standards, Table II C-4.

The lower threshold for analytical instrumentation is usually taken to be twice the maximum noise level generated by the instrument. The lower threshold for the instrumentation employed in the air quality stations is 5 ppb (parts per billion) with the exception of the ozone analyzer for which it is 0.5 ppb; therefore lesser absolute magnitudes of indicated quantities have no meaning. Appropriate conversion factors for each gas allow ppb concentrations to be converted into micrograms/cubic meter(ug/m^3).

Included in Quarterly Report #1, are tables showing pollutant concentration displayed in a bi-variate distribution with wind direction to demonstrate the functional dependence of measured concentrations on wind direction. The small amount of data available seem to indicate that there is a correlation with wind direction to a greater or lesser degree for each site. More data and further analyses are essential before any interpretation can be attempted or conclusions drawn.

Volatile trace metal analysis has indicated the presence of arsine (3 ppb), selenium (0.1 ppb) and mercury (.01 ppb).

Trace element scans of suspended particulates will be reported in subsequent Quarterly Reports.

II C-2 Low Altitude Meteorology

The complex near-surface wind patterns mentioned in the previous subsection vary with elevation above the surface. To assess this vertical variation, a 200-foot meteorological tower has been installed at the site indicated on Figure II C-1.

The Oil Shale Lease Environmental Stipulations require a meteorological tower to be established in reasonable proximity to the proposed plant site to monitor, at least 95% of the time, wind direction and wind speed at three levels, one at least 100 feet above the surface, one at approximately 30 feet, and one at an intermediate level. Humidity is required at one level and temperature at two levels.

TABLE II C-3

AIR QUALITY SUMMARY

(Concentrations in micrograms per cubic meter)

Trailer No. 020 Trailer Location Redd Ranch Period Sept. 1974

Contaminant	Monthly Average	Maximum 24 hr. Concentration		Maximum 8 hr. Concentration		Maximum 3 hr. Concentration		Maximum 1 hr. Concentration		Maximum 5 min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2 (max 24 hr.)	9.1	90.3 103.6	9/15 9/14(16:00)	-	-	146.0	9/14(16:05)	(1) 226.3	9/18(4:35)	264.4	9/14(17:00)
H_2S	1.5	15.7	9/15	-	-	-	-	-	-	47.1	9/13(15:30)
Particulates										-	-
Tot.Hydrocarbons		644.0	9/13			629.7	9/13(6:00)			2515.9	9/13(14:25)
Methane		1569.1	9/7			1712.5	9/7(6:00)			2804.2	9/7(7:05)
Non-CH_4 HC											
Ozone	41.6	74.8	9/10	-	-	-	-	139.4	9/30(5:25)	574.6	9/30(6:05)
NO_x	7.0	12.3	9/26	-	-	-	-	103.3	9/30(15:55)	672.7	9/30(16:05)
NO	1.0	4.1	9/13	-	-	-	-	42.2	9/18(3:30)	64.8	9/18(3:50)
NO_2	5.9	11.1	9/26	-	-	-	-	102.2	9/30(15:55)	672.7	9/30(16:05)
CO	1113.9	1578.4	9/13	1632.0	9/13(6:55)	-	-	2295.5	9/13(14:05)	4901.4	9/17(3:40)

(1) 30 min. instead of 1-hr.

* Start of time interval of occurrence

TABLE II C-4

FEDERAL AND COLORADO AIR QUALITY STANDARDS

	Federal		State			
	Primary	Secondary	Non-Designated Area	1973	1976	1980
Particulate						
Annual G. M.	75 ug/m^3	69 ug/m^3	45 ug/m^3	70 ug/m^3	55 ug/m^3	45 ug/m^3
24 Hr. Max.*	260	150	150	200	180	150
Sulfur Oxides						
Annual	80(.03ppm)		--	60(.02ppm)	25(.009ppm)	10(.004ppm)
24 Hr. Max.*	365(.14ppm)		15(.005ppm)	300(.1ppm)	150(.05ppm)	55(.02ppm)
3 Hr. Max.*	--	1300(.5ppm)	--	--	--	--
1 Hr. Max.**	--	--	--	800(.28ppm)	300(.1ppm)	--
Oxidant						
1 Hr. Max.*	160(.08ppm)	160				
8 Hr. Max.*	--	--				
Annual	--	--				
Hydrocarbons						
3 Hr. Max.* 6-9 a.m.	160(.24ppm)	160				
Carbon Monoxide						
8 Hr. Max.*	10000(9ppm)	10000				
1 Hr. Max.*	40000(35ppm)	40000				
Nitrogen Dioxide						
Annual	100(.05ppm)	100				

Units are micrograms per cubic meter and ppm in parenthesis.
*Not to be exceeded more than once per year.
**Not to be exceeded more than once per month.

As indicated in Table II C-1, low altitude meteorological tower data are obtained at 8, 30, 100 and 200 feet for wind direction and speed, relative humidity, and temperature. Barometric pressure and daytime solar radiation are obtained at ground level. Temperature differences are obtained between the 30 and 100 foot levels and between the 30 and 200 foot levels as part of an integrated approach toward determination of atmospheric stability.

Basic data include diurnal variations (hourly averages) at the four elevations for wind speed, wind direction (as a vector average), relative humidity and temperature. In addition, diurnal temperature differences between 30 and 100 feet and between 30 and 200 feet are recorded. Daily average values, daily maximum five-minute sliding averages and the time of occurrences and monthly averages are computed for wind speed, wind direction, relative humidity and temperature at each of the four elevations.

II C-3 Upper Air Studies

The purpose of the upper air studies is to obtain wind and temperature vertical profiles from altitudes above the meteorological tower to approximately 6,000 feet above the surface. Furthermore, from knowledge of the changes in the variation in temperature with increasing altitude (called the lapse rate), insights into atmospheric stability are obtained. That is if the actual lapse rate is less than the dry adiabatic lapse rate (DALR) then the atmosphere is said to be stable and the vertical diffusion of gaseous constituents is inhibited; if the actual lapse rate is greater than DALR then the atmosphere is unstable and diffusion proceeds freely in both the horizontal and vertical directions. Cases where air temperature increased with height are called inversions, resulting in a layer of extreme stability; inversions lead to slow dispersion of gaseous constituents.

There are no requirements in the Oil Shale Lease Environmental Stipulations for upper air studies. They are required in Conditions of Approval from the Area Oil Shale Supervisor. Two winds-aloft and temperature profiles per day to altitudes of 6000 feet above the Tract are required for a minimum of 15 days per quarter.

Data for this reporting period were obtained by E. G. & G. consultants for the wind and temperature profiles during the 15 day period from October 1 - 15, 1974. Winds aloft were obtained from pibal releases at the meteorological tower; temperatures aloft were obtained via an instrumented aircraft. A representative example of four temperature soundings on 10 October 1974 is given in Figure II C-2; the presence of a strong inversion layer from the surface to 7400 feet at 0524 hours is to be noted. Comparisons of temperature profiles with the C-a Tract and with Grand Junction (GJT) are presented in Quarterly Report #1. A representative sample for the nominal 0800 sounding on the same date is given in Figure II C-3.

In general, results showed that the temperature structure above the Tract followed the dry adiabatic lapse rate very well above 1500 feet on clear days; on moist days the temperature structure showed more

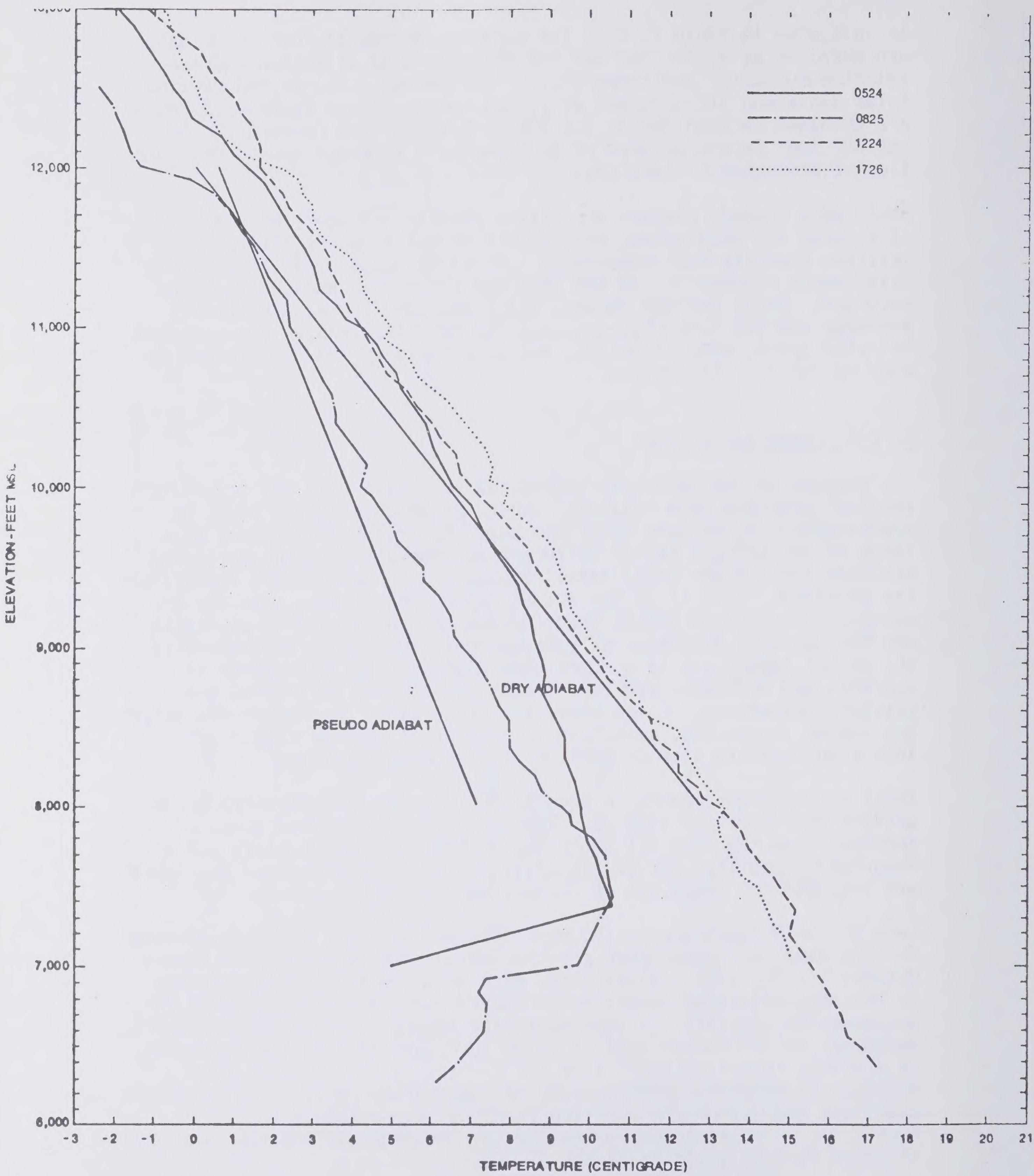


Figure II C-2 Temperature Soundings Over Tract C-b on 10 October 1974

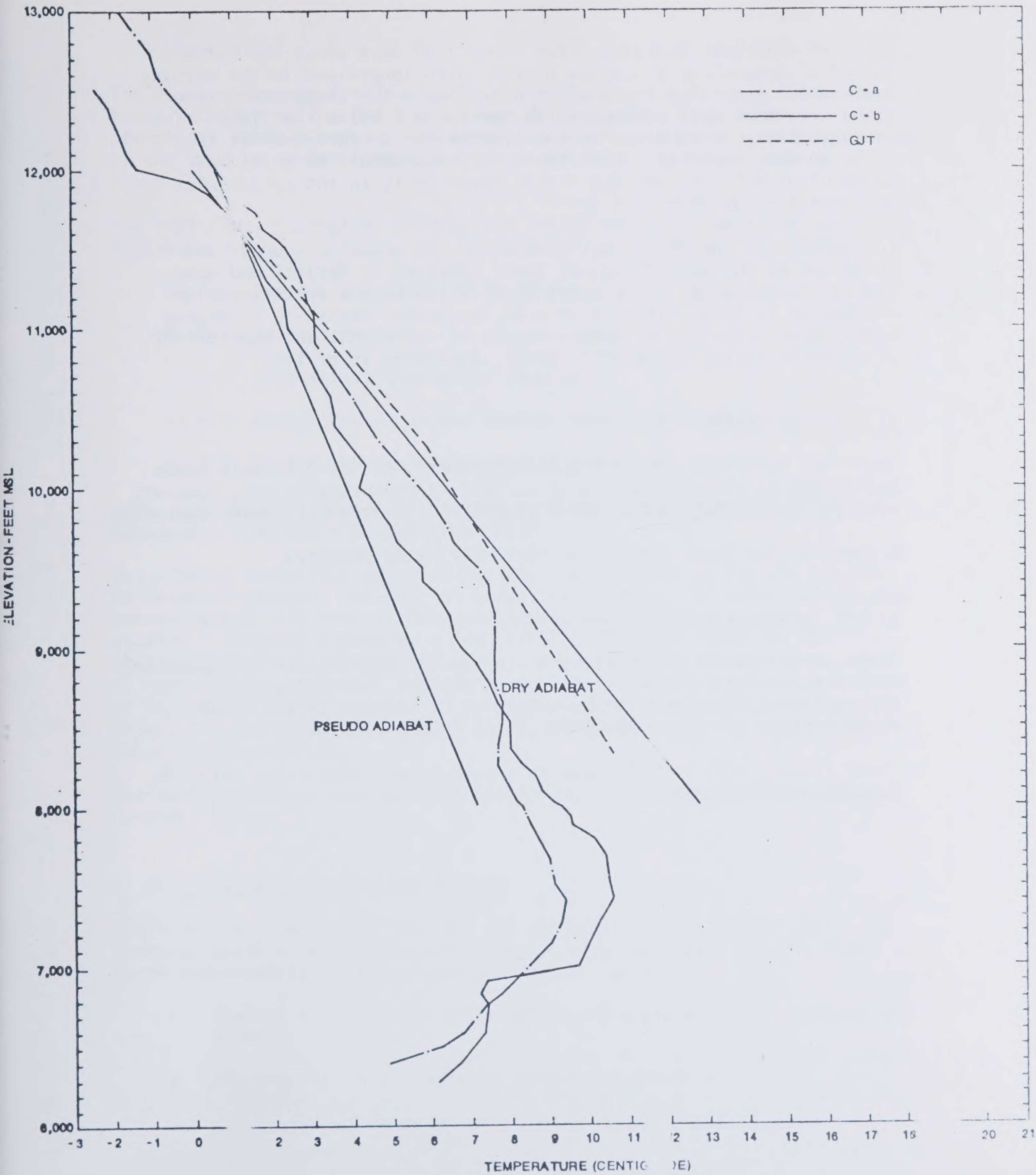


Figure II C-3 Comparison of Vertical Tempera re Soundings Made at 0800 on 10 October 1974 for Tra C-a and C-b

of a wet adiabatic behavior. The lower 1500 feet above the surface showed a somewhat more complex profile with inversions in the morning hours which generally broke up by afternoon. The temperature inversions were much more pronounced in the valleys below the Tract. The average mixing layer depth in the presence of an inversion at the early morning sounding (about 04:00 MST) was about 750 feet. At about 07:00 MST, the average mixing layer depth in the presence of an inversion was about 500 feet.

In addition to the above instrumentation, an acoustic sounder was installed at the meteorological tower location by Marlatt and Associates, consultants, on December 7, 1974 and became operational as of January 2, 1975. It will be used to further assist in assessing atmospheric stability by determination of the height and time-extent of unstable layers and stable layers, including inversions.

II C-4 Visibility

There are no visibility baseline requirements in the Oil Shale Lease Environmental Stipulations; site visibility measurements are, however, required in the Conditions for Approval by the Area Oil Shale Supervisor.

A proposal for these studies is currently being prepared.

II C-5 Atmospheric Diffusion Studies

There are no baseline requirements in the Oil Shale Lease Environmental Stipulations for atmospheric diffusion studies. Conditions for Approval from the Area Oil Shale Supervisor require ground level concentration estimates for 24-hour and 3-hour averages.

These studies will be initiated at a future date when stack emission data become available.

II D BIOLOGY

The Biology Program for Tract C-b is designed to comply with Flora and Fauna sections of the Oil Shale Lease Environmental Stipulations. Comprehensive studies based on an ecosystem approach should permit prediction of the impacts of development on the ecological systems present on Tract C-b.

The individual biological studies are discussed in the sections that follow:

- II D-1 Terrestrial Wildlife Studies
- II D-2 Aquatic Studies
- II D-3 Terrestrial Vegetation Studies
- II D-4 Dendrochronology and Dendroclimatology Studies
- II D-5 Soil Survey and Productivity Assessment Studies

Data from these studies will be used to develop a Fish and Wildlife Management Plan and a Revegetation Plan.

The primary consultant carrying out the biology studies for the Lessees is Woodward-Envicon, Inc. of San Diego, California. Woodward-Envicon has subcontracted with several Colorado biologists to conduct many of the studies. Stoecker-Keammerer & Associates of Boulder, Colorado are assisting in wildlife and vegetation studies; Ecology Consultants, Inc. of Fort Collins, Colorado are conducting the bird studies; Dr. J. V. Ward of Colorado State University is a consultant for the aquatic ecology study; and dendroclimatology and soil arthropods are being studied by other local scientists.

The various biology studies were started in the summer and fall, August - October, 1974.

<u>II D-1 Terrestrial Wildlife Studies</u>

The wildlife studies on Tract C-b are designed to provide the following baseline ecological information to be in compliance with the Oil Shale Lease Environmental Stipulations concerning fauna.

1. Species lists of the major groups of vertebrate and invertebrate animals
2. Distribution and abundance of these species
3. Structure and dynamics of selected animal populations

4. Functional aspects of these populations to produce a generalized ecosystem model

Where possible, the wildlife studies are quantitative as well as qualitative to enable comparisons with future work.

Quarterly Report #1 contains initial findings of the field investigations from August to November, 1974. Data collection began in mid-August. Figures II D-1 and II D-2 show the location of the terrestrial wildlife study areas for Tract C-b.

Scope

The distribution, abundance, and migration patterns of big game, mainly mule deer, in and around Tract C-b have been monitored this quarter by several techniques, including track counts, road counts, aerial counts, pellet-group counts, and winter mortality counts (see Figures II D-1 and II D-2).

To evaluate the extent to which deer utilize Tract C-b, a shrub utilization study has been designed. The study will yield information on the percentage of utilization and condition of each browse species. In conjunction with the productivity studies conducted by the vegetation team, an estimate of shrub production will be available to compute actual deer utilization for selected browse species.

The degree of competition between mule deer and livestock on Tract C-b will be determined by the amount of area and number of forage species browsed or grazed in common. The distribution and density of both animal species are determined by the presence of deer-pellet groups and cow droppings, with the number of droppings related to the degree of area utilization.

The medium-sized mammals include rabbits and hares, large rodents such as beaver, and smaller predators such as the badger. Track count and other methods are presently used to monitor these mammals.

Most of the major vertebrate predators and prey species in the Tract C-b area have been identified by direct observation, live trapping, vocalizations, track counts, and indirect signs of activity (droppings, dens, remains of kills).

Small mammals expected on Tract C-b include shrews, squirrels and chipmunks, gophers, rats, mice and voles. Small mammals are studied quantitatively using Smith live-traps at two locations, chained pinyon-juniper and an unchained pinyon-juniper woodland. Trapped animals are marked and the sex, life history stage, reproductive state, and presence of parasites are recorded. Qualitative satellite live-trapping grids are located in the minor vegetation habitat types in the Tract area.

Emlen strip transects have been established in eight habitat types in and around Tract C-b to study bird populations (Figure II D-1). Data are used to calculate relative abundance and population density of various species.

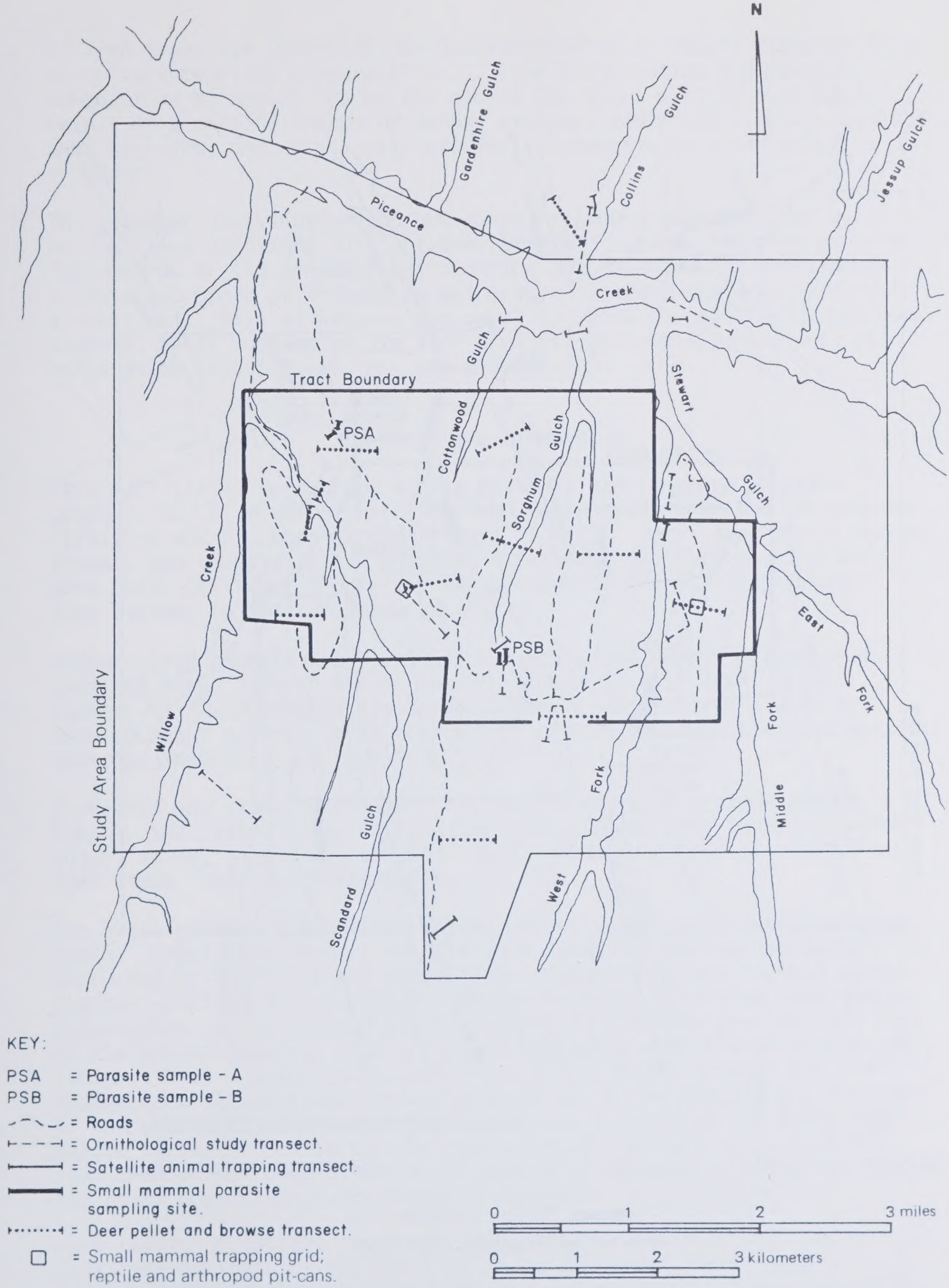


FIGURE
II D-1 TERRESTRIAL WILDLIFE STUDY AREAS

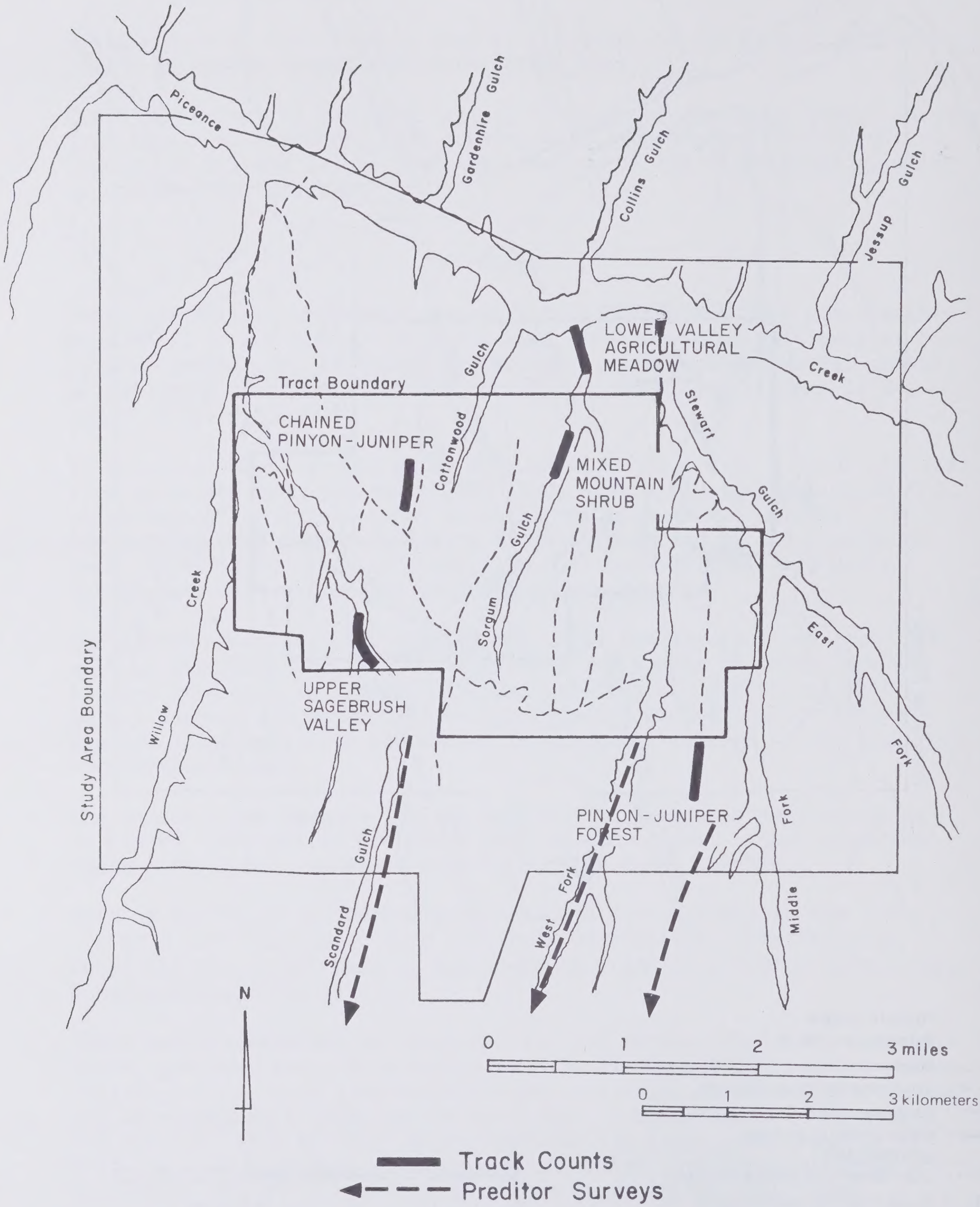


Figure IID-2. LOCATION OF TRACK COUNT TRANSECTS AND PREDITOR SURVEY LINES

Pit-can traps are placed at the quantitative small mammal trapping sites to collect reptiles (Figure II D-1). The distribution and species composition of amphibians on and around the Tract will be evaluated mainly by a reconnaissance of seeps, streams, and ponds. Observations, hand captures, and counts will provide information on their relative abundance.

The seasonal distribution and abundance of ground invertebrates will be described utilizing data obtained from the pit-can trapping program. Information on the seasonal distribution and abundance of non-ground insects and other arthropods is gathered by beating the vegetation with a sweep net. Soil arthropods are separated from the soil using Berlese funnels. Soil subsamples are also used for bacterial/fungal culture preparation, identifications, and enumeration.

Results and Discussion

This fall (1974) deer began moving to their winter range in early October, and by November were observed daily grazing in the hay meadows of Willow and Piceance Creeks (Figure II D-3). Deer leave their bedding grounds and cover sites in the late afternoon and early evening and move north off Tract C-b to the hay meadows to graze. By daybreak they retreat to their bedding sites.

Medium-sized mammals are fairly wide-ranging and widely distributed over the Tract. There are no species unique to this area. A wide variety of these mammals are found in and around Tract C-b with the more abundant species being cottontail rabbits, jackrabbits, and possibly marmots, raccoons, and skunks.

Predators and raptors observed this summer and fall include coyote, bobcat, red-tailed hawk, and sparrow hawk. Their prey includes cottontails, voles, chipmunks, and wood rats. Dead mule deer also serve as food items, especially for coyotes.

The small mammals include the shrews, mice, voles, wood rats, and chipmunks. Population studies for the more abundant species are being conducted at two permanent study sites representing the chained pinyon-juniper woodland and the pinyon-juniper woodland. To date, the species composition in the chained pinyon-juniper is slightly greater than that in the pinyon-juniper. The increased habitat due to felled pinyon and juniper trees and increased understory growth might account for the difference. The dominant rodent appears to be the deer mouse, followed by the chipmunk. These species also occur in most of the other vegetation types in the Tract. The remainder of the species account for less than 10 per cent of the total number of rodents. In the hay meadows, the voles appear to be the dominant species.

As a result of initial field investigations, a checklist of bird species utilizing habitats on the Tract has been developed. Preliminary results indicate that the birds encountered on Tract C-b are basically those species expected to be present during early and late fall on the basis of published information from northwestern Colorado and northeastern Utah.

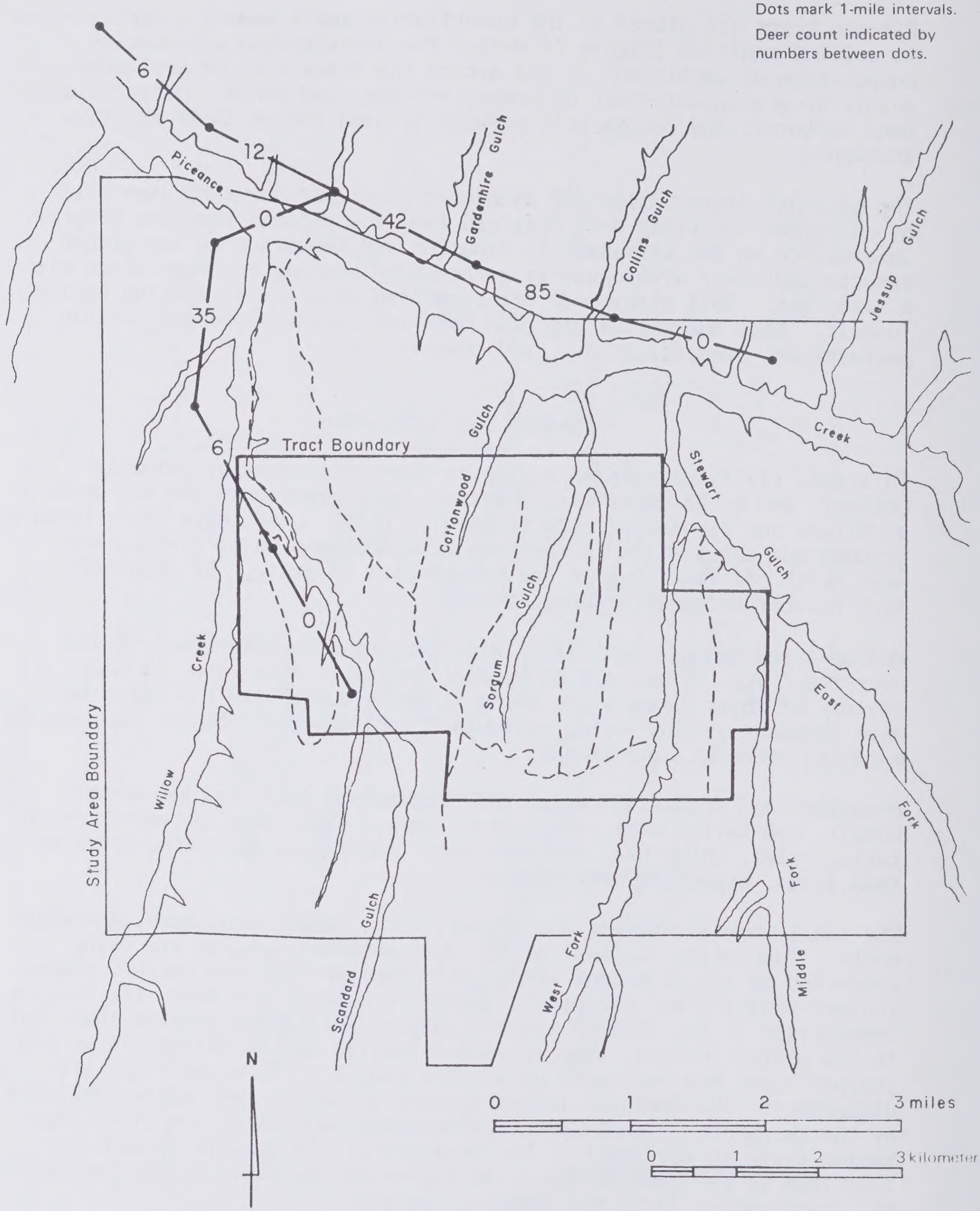


Figure II D-3 DEER CONCENTRATIONS, NOVEMBER 12, 1974

Nineteen bird species were observed during early fall; the most abundant species within the pinyon-juniper and sagebrush habitats were the mountain bluebird, Townsend's solitaire, and yellow-rumped warbler. The riparian area was inhabited principally by mourning doves, white-crowned sparrows, and song sparrows. By late November, most migrants had left the area, leaving only those species which are expected to winter on the Tract. The pinyon-juniper and sagebrush habitats were inhabited principally by the white-breasted nuthatch, American robin, Townsend's solitaire, and northern shrike. Typical birds found in the hay meadow habitat during late November included the American robin, starling, white-crowned sparrow, and song sparrow. The most abundant waterfowl noted were mallards, green-winged teal, and blue-winged teal. The occurrence of nine raptor species was documented during this quarter. Red-tailed hawk, rough-legged hawk, golden eagle, marsh hawk, and American kestrel comprise the diurnal species noted, while the barn owl, screech owl, great-horned owl, and long-eared owl were recorded during nocturnal surveys.

II D-2 Aquatic Studies

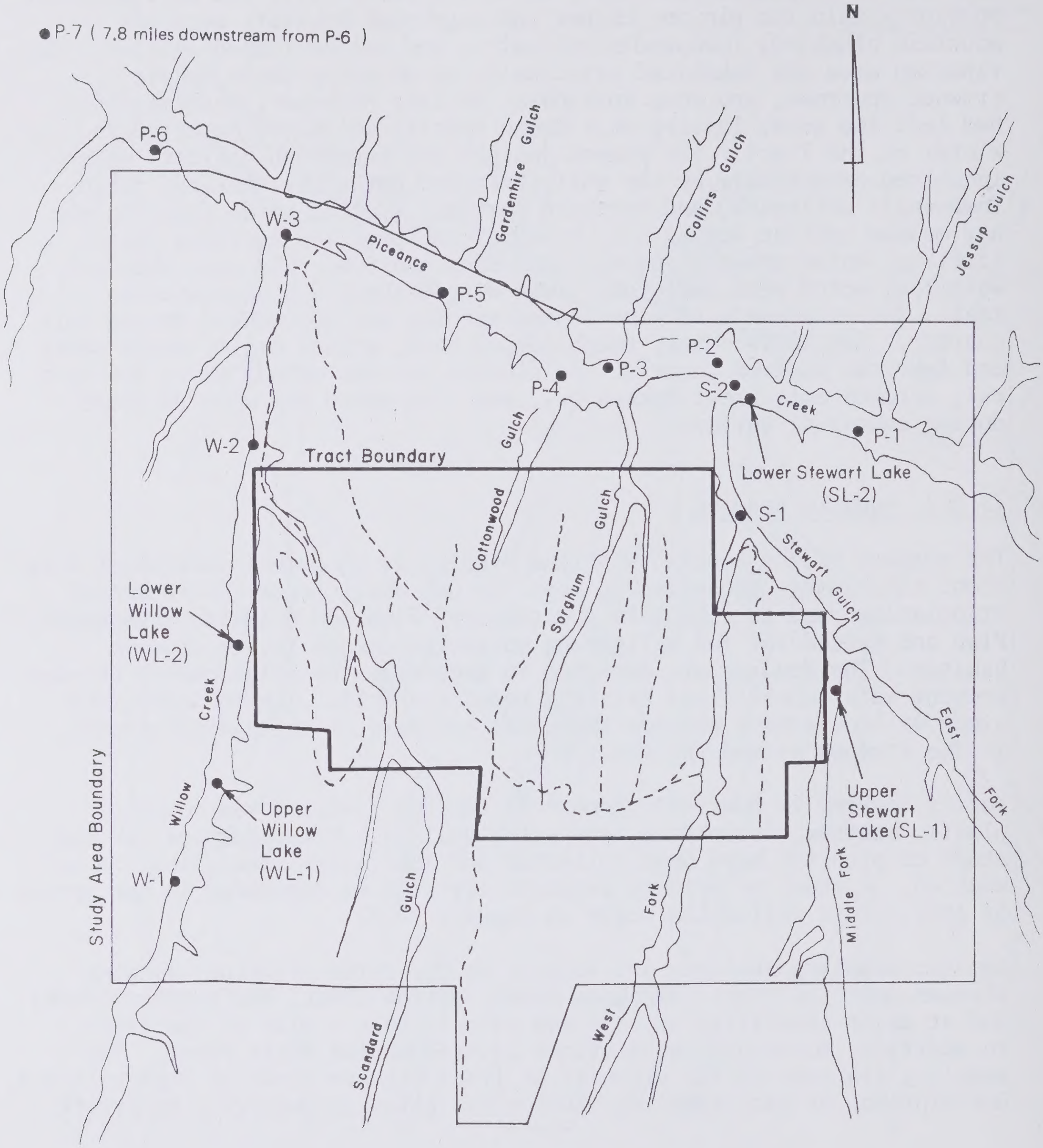
The purpose of the aquatic baseline studies is to gather sufficient data about the aquatic ecosystem to meet the Oil Shale Lease Environmental Stipulations and to formulate the required Fish and Wildlife Management Plan and procedures for mitigating potential damage to the aquatic habitat. The studies are designed to ascertain the relationship between present water quality and existing aquatic species. In addition, the study will determine whether there are any rare or endangered species in the streams around the Tract area.

Topics covered in Quarterly Report #1 include fish, rooted aquatic plants, benthos, periphyton, and water quality. Water samples for the study of plankton have been collected and laboratory identification is awaited. A study of primary productivity will be commenced in the spring of 1975. Data collection began in August, 1974.

Aquatic sampling stations are located on the three principal flowing streams near the Tract (Piceance Creek, Willow Creek, and Stewart Creek) and at major identified springs and seeps within a mile of the Tract. In addition, there are two stations located on the White River. The sampling stations in the vicinity of Tract C-b are shown on Figure II D-4. Descriptions of each sampling station are given in Quarterly Report #1.

Scope

Fish specimens are collected from the streams on a bi-monthly basis using a battery-operated backpack shocker. In the lakes and ponds, two 0.5-inch-mesh nylon seines are used to collect fish. Fish are marked and released to study possible migration patterns. Benthic organisms (bottom dwelling invertebrates) are sampled with a standard square-foot Surber sampler. Periphyton (attached plants and microinvertebrates) are collected on removable glass slides placed in a holder which has been immersed in the stream for about a month. Plankton are



NOTE.

Piceance Creek sites (P-1 thru P-7)
Willow Creek sites (W-1 thru W-3)
Stewart Creek sites (S-1, S-2)
= Roads

0 1 2 3 miles

0 1 2 3 kilometers

Figure II D-4 AQUATIC STUDY AREAS

collected using a millipore filter. Primary productivity is determined by the light/dark bottle method.

Water samples are collected from those stations not covered by the U.S.G.S. surface water program. Measurements were made this quarter of the dissolved oxygen, pH, temperature, specific conductivity and of those cations and anions which were indicators of water hardness, organic and inorganic cations and anions, and bacteria and pathogen cultures.

Results and Discussion

Fish were collected during September and November as part of the aquatic baseline studies. Three species of game fish and four species of rough fish have been collected from the waters draining Tract C-b and from the White River (Table II D-1). When the numbers of the fish species are compared, the mountain sucker is the abundant species and brook trout is the second highest in abundance. The trout population is concentrated in Lower Stewart Lake and its drainage channel. The greatest numbers of fish occurred at Piceance Creek stations having a rocky substrate which seem to offer better habitat for fish than did other stations. There also seems to be a general trend for numbers of fish to increase in an upstream direction.

Benthic invertebrates were collected during September and October. Notable at this time is the rich production of more desirable fish food species (mayflies, damselflies) within upper Stewart and Willow Lakes (Tables II D-2 and II D-3). The absence of fish populations within these lakes allows the more desirable benthic species to increase unchecked. Also noteworthy is that the lowermost stations of Piceance Creek (P-6 and P-7) have by far the poorest benthic species composition. This is attributed to the mud and compact clay substratum in these areas, which provide no points of attachment for benthic fauna.

At this time the analysis of periphyton collected from the immersed glass slides is incomplete. It should be noted, however, that diatoms are by far the most abundant form of periphyton.

Water samples were collected in August, September and October. Data for Piceance Creek is presented in Table II D-4. Notable at this time is the consistent increase in calcium, magnesium, sodium, sulfate, and bicarbonate from August to October. Such increases are probably related to reduced stream flow. Another notable change is the fecal coliform count for Piceance Creek shown in Table II D-5. The increase in these coliform levels seem related to the presence of cattle on the meadows along Piceance Creek.

Plankton and primary productivity data have not been sufficiently analyzed for inclusion in this report. Results and discussion of these portions of aquatic study will be in the next Quarterly Report.

TABLE II D-1

NUMERICAL ABUNDANCE OF SPECIES OF FISH CAPTURED DURING SEPTEMBER AND NOVEMBER 1974

	SPECIES							
STATION	Rainbow Trout	Brown Trout	Brook Trout	Flannel-mouth Sucker	Mountain Sucker	Speckled Dace	Mottled Sculpin	Total Number
P-1		1	1		148	30		180
P-2					38			38
P-3					50	2		52
P-4					3	2		5
P-5	2				20			22
P-6					18	6		24
P-7					2			2
WR-1				1			2	3
WR-2							6	6
W-1								
W-2								
W-3			3		2	1		6
WL-1								
WL-2								
S-1								
S-2								
SL-1								
SL-2			93					93
	2	1	97	1	281	41	8	431

TABLE II D-2

STEWART CREEK AND STEWART LAKES. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA COLLECTED DURING SEPTEMBER AND OCTOBER, 1974.

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Mayflies	3	19	3	13	6	24		101	43		9	1	222
Damselflies								69	86				155
													TOTAL. 377
OCTOBER													
Mayflies	8	7					1600			8			1,621
Damselflies							5						5
													TOTAL. 1,626

TABLE II D-3

WILLOW CREEK AND WILLOW LAKES. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA COLLECTED DURING SEPTEMBER AND OCTOBER, 1974.

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2*			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Mayflies		4	5	8	8	8	67	14	37	98	37	83				218
Damselflies											11	7				18
															TOTAL.	236
OCTOBER																
Mayflies					6		5	3		81						95
Damselflies										25						25
															TOTAL.	120

*Samples were unidentifiable

TABLE II D-4

MINERAL AND NUTRIENT CONTENT (in mg/l) OF SELECTED PICEANCE CREEK STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
STATION P-1											
August	22	50	120	2.8	0.89	0	24	342	166	25	1.4
September	66	35	138	1.9	0	0	12	476	155	17	0.35
October	52	49	140	3.1	0	0	6	512	165	20	0.13
STATION P-3											
August	22	46	136	2.9	0	0	36	323	186	20	2.0
September	44	56	141	2.0	0	0	12	427	232	19	1.7
October	68	63	144	2.3	0	0	12	500	277	20	1.2
STATION P-6											
September	32	56	144	3.5	0	0	48	348	218	30	1.6
October	58	62	159	2.0	0	0	12	482	277	15	0.80

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrite (N)	Nitrate (N)	(Total) Alkalinity ($CaCO_3$)	(Total) Hardness ($CaCO_3$)	Dissolved solids
STATION P-1											
August	0.04	0.69	0.38	16	0.74	0	0	0.31	320	260	636
September	0.08	0	0.18	14	0.83	0	.001	0.08	410	310	716
October	0.05	0	0.17	17	0.43	0	0	.003	430	330	920
STATION P-3											
August	0	0	0.17	16	1.0	0	0	0.45	325	245	724
September	0	0	0.18	18	1.3	0	.005	0.38	370	340	764
October	0.04	0	0.18	18	0.21	0	0	0.26	430	430	956
STATION P-6											
September	0.07	0	0.18	18	0.19	0	0	0.37	365	310	680
October	0	0	0.18	20	1.3	0	.003	0.18	415	400	880

TABLE II D-4

MINERAL AND NUTRIENT CONTENT OF SELECTED PICEANCE CREEK STATIONS TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

Page 2

	Dissolved Oxygen (ppm)	pH	Specific Conductance (μ mhos)	Temperature (°F)
STATION P-1				
August	7.0	8.2	1075	61
September	10.0	9.1	1125	56
October	11.0	8.1	1200	54
STATION P-3				
August	6.0	8.2	1075	59
September	11.0	9.0	1225	51
October	11.0	8.2	1300	51
STATION P-6				
August	6.0	8.4	1075	59
September	10.0	8.8	1475	47
October	U.S.G.S.			

TABLE II D-5

MICROBIOLOGY OF SELECTED PICEANCE CREEK STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Standard Plate Count/ml at 35°C.	Coliform *MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
STATION P-1					
August	840	4,600	43	--**	--
September	1,000	43	9	<3	Not detected
October	210,000	110	<3	93	Not detected
STATION P-3					
August	7,600	4,600	240	--	--
September	190	2,400	9	<3	Not detected
October	180,000	>24,000	<3	240	Not detected
STATION P-6					
August	8,900	>24,000	93	--	--
September	220	2,400	460	<3	--
October	--	--	--	--	--

*MPN = Most Probable Number

**-- = Sample not collected(?)

II D-3 Terrestrial Vegetation Studies

The vegetation studies on Tract C-b are designed to provide baseline ecological data on the structural, compositional, and functional aspects of the vegetation. The comprehensive study of the existing vegetation is of sufficient detail that future changes in species composition or vegetation structure and function can be detected by comparison with pre-development baseline ecological data. Data collection began in mid-August.

Scope

Twelve permanent vegetation study plots have been established at six locations (Figure II D-5). One pair of study plots is located in each major vegetation type (chained pinyon-juniper woodland, plateau sagebrush shrubland, valley sagebrush shrubland, and pinyon-juniper woodland). Of the six locations, two are in chained pinyon-juniper woodlands, two are in pinyon-juniper woodlands, and one each in plateau sagebrush shrubland and valley sagebrush shrubland. One of the chained pinyon-juniper locations and one of the pinyon-juniper locations are established near areas of anticipated development. The remaining locations of these two vegetation types are established in remote areas of the Tract where no impact from development is anticipated. The locations of the two sagebrush shrubland types are in areas that are expected to receive minimal impact from development. At all six locations one of the paired plots is fenced to exclude livestock and deer and the other is left open for grazing. This will permit a determination of the effects of grazing on the vegetation. With this design, four treatments on the pinyon-juniper and chained pinyon-juniper can be monitored:

1. Oil shale development and grazing
2. Oil shale development and no grazing
3. No oil shale development and grazing
4. No oil shale development and no grazing

The data being collected in each of the study plots are listed in Table II D-6.

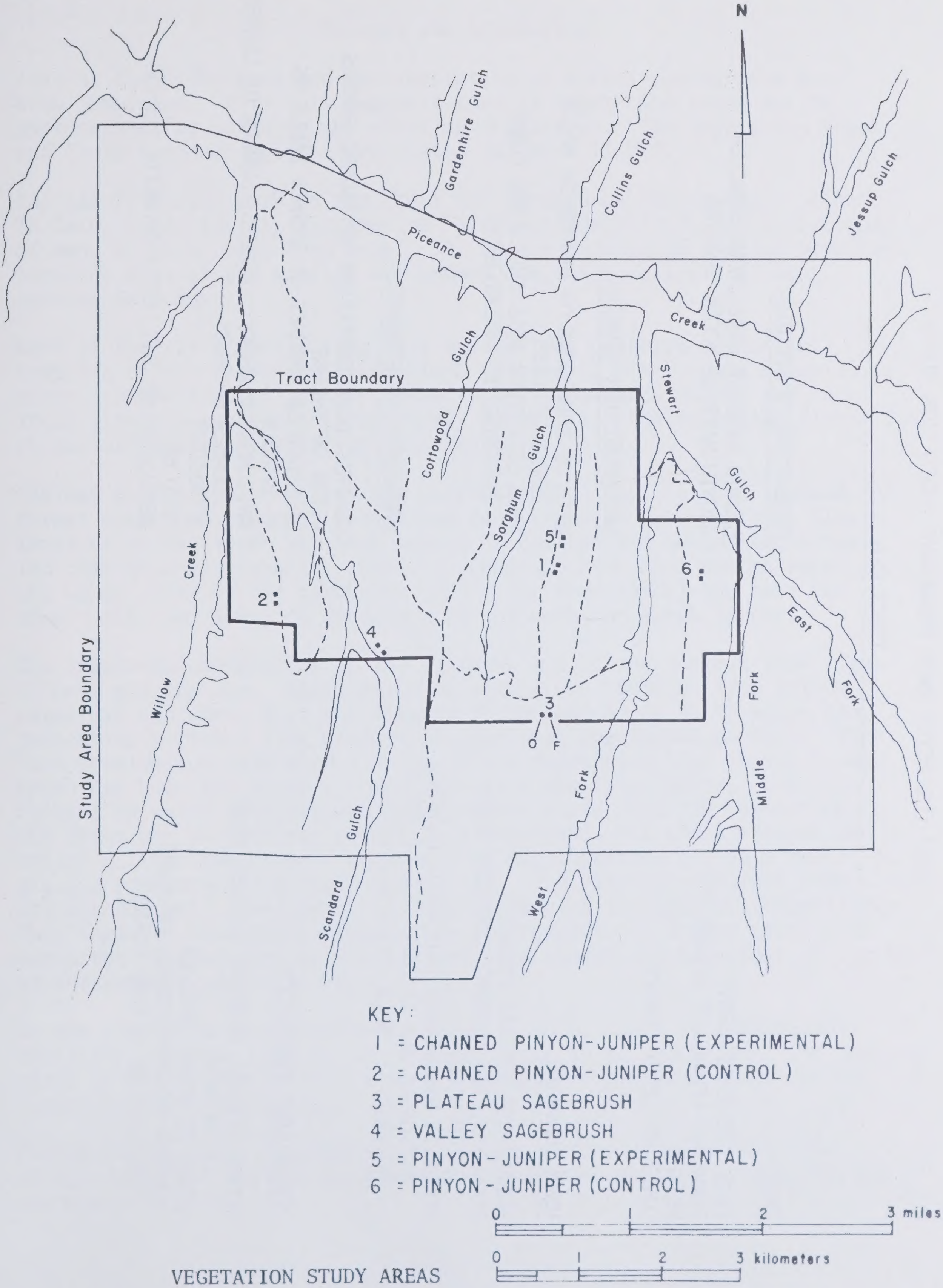
Plant community studies are designed to differentiate the vegetation assemblages based on species composition and the existence of man-induced disturbance. Productivity within the herb layer of the major vegetation types is estimated by clipping randomly located quadrats at intervals throughout the growing season. Shrub productivity is estimated by clipping stems of selected shrubs.

Nylon decomposition bags are used to determine the rate at which plant litter decomposes in the major vegetation types. Leaves from mountain mahogany, serviceberry, and sagebrush, as well as a cellulose standard have been used for this study.

Litter traps are used to determine the rate of litter fall in the major plant communities and the rate at which dead plant material is made available to decomposer organisms.

Seasonal development observations for shrubs will be restricted to the

FIGURE II D-5



VEGETATION STUDY AREAS

TABLE II D-6

DATA COLLECTED FROM PERMANENT VEGETATION PLOTS

TRACT C-b

TREES:

TREE SPECIES PRESENT
DIAMETER AT BREAST HEIGHT
HEIGHT
COVER BY LEAFY CANOPY

HERB QUADRATS:

HERBACEOUS SPECIES PRESENT
WOODY SPECIES PRESENT (SMALLER THAN 25 CM HIGH)
COVER BY HERBACEOUS AND WOODY PLANTS, BY MOSSES AND LICHENS AND BY OTHER MATERIALS: ROCK, SOIL & LITTER

SHRUB BELT TRANSECTS:

WOODY SPECIES PRESENT (LARGER THAN 25 CM HIGH)
COVER BY WOODY SPECIES
NUMBERS OF INDIVIDUALS OF EACH SPECIES BY HEIGHT CLASS

PRODUCTIVITY STUDIES:

GROWTH RATE OF HERBACEOUS SPECIES
GROWTH RATE OF WOODY SPECIES

DECOMPOSITION STUDIES:

RATE OF BREAKDOWN OF LEAVES OF MAJOR SHRUB SPECIES
RATE OF LITTER FALL SUPPLYING PLANT MATERIAL TO DECOMPOSERS

PHENOLOGICAL STUDIES:

GRAPHIC REPRESENTATION OF TAGGED SHRUBS
VIGOR OF SHRUBS
PRESENCE OR ABSENCE OF INSECT FALLS ON SHRUBS
TWIG MEASUREMENTS: LENGTH, NUMBER OF LEAVES, NUMBER OF BUDS
FLOWERING
SEED SET
BEGINNING OF THE PHOTOSYNTHETIC PERIOD

same species being used for the decomposition studies. Individual twigs on plants of these species have been marked and measured so that it will be possible to document growth and development of each shrub.

Results and Discussion

Initial field-checking and interpretation of aerial photographs have been completed. This work suggests that 14 vegetation types may be appropriate for defining the existing vegetation. The vegetation types and their dominant species are listed in Table II D-7.

Initial floristic work on the Tract has focused on the vascular plants. To date, approximately 190 species have been identified, and collections of many of these have been made. No rare or endangered species have been located; most of the species are common and characteristic of west central Colorado.

Much of the field work during this quarter was centered on initial sampling of the intensive study plots (Figure II D-5). Data summarizing cover, composition, frequency, density and importance values for each study site are available in Quarterly Report #1. The following discussion characterizes each vegetation study site.

Chained pinyon-juniper sites are successional. Chaining has removed the forest cover and produced unbalanced conditions in these sites. Similarities in the shrub and herb layers of chained and nonchained sites indicate that disturbances caused by chaining have been concentrated in the upper layer of the community (i.e., the tree layer) and have not caused the same level of imbalance in the herb and shrub layers.

The sagebrush communities on the plateaus and in the valleys show signs of past grazing use. Examination of stem cross sections from valley sagebrush has shown that the largest shrubs may be 60 to 70 years old, indicating a rather long history of sagebrush vegetation on these sites. This observation indicates a valley floor vegetation type in which sagebrush has been the primary component since the late 1800's. Stories related by early settlers and homesteaders state that the vegetation in the draws and valleys was primarily a grassland. If these stories are reliable, then the present dominance of big sagebrush may be a result of grazing pressures from sheep and cattle. The plateau sagebrush communities possess the best developed herb layer of any of the sampled communities. This suggests that these communities are remnants of former grasslands since the long history of grazing may have caused the sagebrush to increase at the expense of the herbs.

In the pinyon-juniper woodlands, Sites 5 and 6, there is considerable variation. Pinyon pine is the dominant tree in all woodlands; the dominant shrub is big sagebrush; serviceberry and pinyon pine samplings are the secondary shrub dominants.

Productivity, plant development and decomposition studies have been designed and the initial work has been completed so that data gathering can begin in 1975.

TABLE II D-7

PLANT COMMUNITIES

VEGETATION TYPE	DOMINANT SPECIES
Pinyon-juniper woodland/ Open understory	Pinyon pine Utah Juniper Rocky Mtn. Juniper
Pinyon-juniper woodland/ Shrubby understory	Pinyon pine Utah Juniper Rocky Mtn. Juniper
Douglas-fir forest	Douglas fir
Chained pinyon-juniper woodland	Big sagebrush Mountain mahogany Antelope bitterbrush
Valley sagebrush community	Big sagebrush Winterfat Rubber rabbitbrush
Plateau sagebrush community	Big sagebrush
Rabbitbrush community	Rubber rabbitbrush
Greasewood community	Greasewood
Mixed mountain shrub community	Gambels oak Serviceberry Mountain mahogany Snowberry Big sagebrush
Bunchgrass community	Indian ricegrass Blue-bunch wheatgrass Sulfur flower Sagewort Pasture sage
Marsh	Cattail Common reed Sedge
Hay meadows	Alfalfa Timothy Sedge
Annual weed communities (disturbed sites)	Russian thistle Pigweed Mountain peppergrass
Sprayed sagebrush sites	Big sagebrush Rubber rabbitbrush Winterfat

Conclusion

It is premature to suggest conclusions at this stage of the Terrestrial Vegetation Study; however, initial observations include:

1. To date, no rare or endangered vascular plant species have been located on Tract C-b.
2. Initial data suggest that there is considerable variation within the chained pinyon-juniper woodland and in the pinyon-juniper woodland.
3. Communities dominated by a big sagebrush may have replaced grasslands as a consequence of the introduction of cattle and sheep during the homestead days.
4. The fenced and open plots at each site show high similarity to each other, which will allow for meaningful comparison in the future.

II D-4 Dendrochronology and Dendroclimatology

Dendrochronologic and dendroclimatic studies in the Tract C-b area are intended to (1) produce a master chronology that dates the growth increments of pinyon pine for the area, and (2) use climate information and dated growth layers to study variations in past and present climates. The widths of growth rings can serve as natural records of climate when they vary as a function of some limiting environmental factor. In semiarid western Colorado, that limiting factor is precipitation.

Three sampling sites were chosen within the study boundaries of Tract C-b, and two sampling sites were selected outside the Tract boundaries. Each stand consisted of eight trees within close proximity. Four cores were taken from each tree at about 4.5 feet above the ground. After the cores were analyzed, a composite chronology for each stand was constructed. Three chronologies have been completed. Until all five chronologies are completed, nothing can be said regarding the master chronology for the area. A description of the past climatic trends will be developed after all the tree rings have been measured, interpreted and statistically analyzed.

II D-5 Soils and Productivity Assessment

The soils studies are designed to satisfy the requirements of the Oil Shale Lease Environmental Stipulations and to provide necessary information about soils to permit the rehabilitation of areas disturbed by the proposed development. In addition, the physical and chemical characteristics of soils in the area planned for spent-shale disposal will be determined.

Before field work can commence, it is necessary to establish soil series and soil types so that classifications of Tract C-b and its vicinity

will be based on nomenclature compatible with the national soil classification system. The Soil Conservation Service in Glenwood Springs, Colorado has been contacted for this information.

Since most of the ground is now either frozen or covered with snow, field work will be delayed until the spring of 1975. It is anticipated that the soils study will be completed by the end of September, 1975.

In December, soil samples will be obtained at the site to initiate greenhouse studies for determining the productivity of various soil types.

III A FISH AND WILDLIFE MANAGEMENT PLAN

A Fish and Wildlife Management Plan is required by the Oil Shale Lease Environmental Stipulations.

A draft Program Statement outlining the areas which should be addressed in this Plan has been developed. The Program Statement is contained in Quarterly Report #1. The primary emphasis will be on those species of economic importance, endangered or threatened status, rarity, uniqueness, or high aesthetic value. The Plan will consider the effects of oil shale development with regard to impact on habitat, impact on wildlife and livestock populations, and impact on recerational use. It will also include evaluative procedures to judge the degree of success of mitigative measures.

Data collection from available local, state, and federal sources which relates to fish and wildlife species and habitats in the Piceance Basin will begin early in the next quarter. Also, a thorough review will be made of existing and developing plans for the management of fish and wildlife and their habitats in the Piceance Basin. Work will be coordinated with the Energy Impact Wildlife Management Plan Coordination Committee.

The final Fish and Wildlife Management Plan will be submitted in the Detailed Development Plan.

III B REVEGETATION PROGRAM

The Revegetation Plan for Tract C-b is in the preparatory stage, with initial field work scheduled for the spring of 1975. Development of a revegetation plan will utilize information from other revegetation efforts throughout the region. Current planning is being directed toward the rehabilitation of areas disturbed by exploration activities.

In formulating the initial activities for spring, 1975, data have been gathered from an experimental plot on Tract C-b. This plot was established by the Colorado Department of Natural Resources in 1972. An evaluation of species growing in this surface disturbance plot evaluation (Table III B-1) has been made and a tentative list of species for potential planting in disturbed areas is given in Table II B-2.

The basis for revegetation planning and future experimental studies are the following criteria:

1. Erosion control and surface stabilization
2. Support of wildlife
3. Accommodation of natural successional events
4. Latest state of the art revegetation/rehabilitation procedures
5. Application of pertinent biological information gathered on Tract C-b

TABLE III B-1

RESULTS OF EVALUATION OF SURFACE DISTURBANCE PLOTS
(COLORADO DEPARTMENT OF NATURAL RESOURCES) ON TRACT C-b

SPECIES	RATING*
Yellow sweet clover	fair
Thickspike wheatgrass	fair
Palmer penstemon	v. good
Western wheatgrass	fair
Basin wildrye	poor
Alfalfa	poor
Bluegrass	poor
Siberian wheatgrass	good
Mountain brome	good
Burnet	poor
Intermediate wheatgrass	v. good
Crested wheatgrass	good
Skunkbrush	poor
Salina wildrye	poor
Pubescent wheatgrass	v. good
Antelope itterbrush	fair
Durar hard fescue	fair
Intermediate wheatgrass	v. good
Smooth brome	fair
Alkali sacaton	poor
Indian ricegrass	fair
Bent grass	poor
Gooseberry leaf globemallow	good
Mountain penstemon	fair
Meadow brome	fair
Utah sweetvetch	good
Cliffrose	v. good
Mountain mahogany	fair
Desert bitterbrush	good
Tall wheatgrass	fair
Needle-and-thread grass	good

*Rating Factors

(growth, vigor, stand density)	Very Good
"	Good
"	Fair
"	Poor

TABLE III B-2

RECOMMENDED SEED LIST FOR SURFACE DISTURBANCE AREAS ON TRACT C-b

GRASSES:	lbs/acre
Thickspike wheatgrass	1
Crested wheatgrass	1
Intermediate wheatgrass	2
Intermediate wheatgrass	2
Western wheatgrass	1
Slender wheatgrass	1
Pubescent wheatgrass	2
Mountain brome	2
Indian ricegrass	1
Needle-and-thread	1
FORBS:	**lbs/acre**
Utah sweetvetch	½
Palmer penstemon	½
Gooseberry leaf globemallow	½
SHRUBS:	**lbs/acre**
Mountain mahogany	2
Stansbury cliffrose	2
Antelope bitterbrush	2
TOTAL	21½

III C MICROENVIRONMENTAL PROGRAM

In February 1975, microenvironmental study will begin to obtain data on certain physical parameters of the environment in which living things operate. Ball Brothers Research Corporation will supply the instrumentation. The stations, once established, will be operated by C-b Shale Oil Project personnel.

Although the program is not a required activity, the data obtained from this program, will be helpful in the design of the rehabilitation program. Four stations will be installed, one in each of the four major vegetation types (chained pinyon-juniper, pinyon-juniper, valley sagebrush, and plateau sagebrush). The stations will record the information listed in Table III C-1. Additonal spot-check sites and survey points have been established. These satellite areas were established to assess possible significant microenvironmental differences in other habitat and topography.

TABLE III C-1

MICROENVIRONMENTAL INSTRUMENTATION

Data Operation		Satellite Areas	Continuous Recording
(1)	Free Air Temperature		X
(1)	Soil Temperature		X
(2)	Min-Max Temperature	X	
(5)	Soil Moisture	X	
(1)	Wind Speed/ Direction		X
(3)	Relative Humidity		X
(3)	Solar Radiation (Net)		X
(5)	Snow Depth, Density Distribution	X	
(2)	Evaporation	X	X
(4)	Precipitation	X	X

(1) At four permanent stations (Chained Pinyon-Juniper, Pinyon-Juniper, Valley Sagebrush and Plateau Sagebrush)
(2) At ten relocatable sites (potential instrumentation up to 16)
(3) At one site only, permanent station (Chained Pinyon-Juniper)
(4) At four permanent stations and ten relocatable sites
(5) At 12-16 permanent sites (four of these overlap with one)

III D AERIAL PHOTOGRAPHIC STUDY

Aerial photographic coverage of Tract C-b and vicinity has been produced by Towhill, Inc., San Francisco. The following materials were produced at the scales indicated:

A. Scale of 1" - 500'

1. Color
2. Color oblique
3. Color infrared
4. Black and white

The area of coverage for these photographs occurs on Jessup Gulch and Rock School USGS 7½' Topographic Quandrangles. The following Sections are covered:

T2S R96W Sections 30 - 34
T2S R97W Sections 25 - 27, 34 - 36
T3S R96W Sections 3 - 10, 15 - 22, 29 - 32
T3S R97W Sections 1 - 3, 10 - 15, 22 - 25, 36

B. Scale of 1" - 3500'

Black and white coverage of areas included in the following USGS 7½ Topographic Quandrangles:

1. Yankee Gulch
2. Rock School
3. Jessup Gulch
4. No Name Ridge
5. Thirteen Mile Creek
6. Rio Blanco
7. Highmore
8. Parachute Creek

The above photographic materials will be used for:

1. Vegetation mapping
2. Soil mapping
3. Surficial geology mapping
4. Geologic joint and fracture analysis
5. Plant design such as location of sites for water impoundments, mining and processing facilities, spent shale disposal areas, pipelines, mine access and road locations.

III E ARCHAEOLOGICAL STUDIES

The Oil Shale Lease Environmental Stipulations require that "the Lessee shall, prior to construction or mining, conduct a thorough and professional investigation of any portion of the Leased Lands to be used, including, but not limited to, those to be used for mining, processing, or disposal operations or roads, for objects of historic or scientific interest, including, but not limited to, Indian ruins, pictographs, and other archaeological remains."

An archaeological team headed by Dr. Calvin H. Jennings of Colorado State University has completed a study to determine the level of archaeological or historic significance of Tract C-b. Because of a desire by the Area Oil Shale Supervisor's office that the report of the results of these investigations be subjected to peer review prior to finalization, the report is not yet available.

The archaeological survey of Tract C-b located three previously unknown sites. These sites, in association with two others adjacent to the Tract constitute the known resource of the area. The sites consisted primarily of scattered flakes, burned bone, a projectile point, various fragments, and the remains of an uninhabited cabin. These are not interpreted as being of particular significance on either the national or regional level. The lack of significance is based on the comparison of the Tract C-b resources with those of other portions of the Piceance Basin where site densities were found to be higher and where sites showed evidence of more intensive occupational intensity. No sites were found which would be considered as eligible for nomination to the National Register of Historic Places.

III F SCENIC VALUES PROGRAM

The Oil Shale Lease Environmental Stipulations require that the Lessee take into consideration existing aesthetic values in all planning, construction, reclamation and mining operations. All operations are required to be performed so as to minimize visual impact, make use of the natural topography, and to achieve harmony with the landscape.

In order to meet these requirements, the type and quality of scenic resources which exist in the Tract C-b area, as well as the relationship of these to the overall scenic resources of the surrounding area are being considered. This program will study all seasons, with the main effort planned during the next two quarters.

The scenic values study will be correlated with the development planning phase for the Tract, so that planned development alternatives may be evlauted as to their aesthetic impact, and recommendations may be made to minimize any potentially adverse scenic impact.

A photographic history of the Tract, which is an ongoing project, will provide documentation of changes in the visual resources of the area.

MAP OF

OIL SHALE TRACT C-b

Environmental and Exploration Activities

1 map enclosed

LEGEND

- Water Gaging Station
- Air Quality Meteorological
- Support Facilities
- Aquatic Sampling Site
  - PC - Piceance Creek
  - WC - Willow Creek
  - SC - Stewart Creek
- Vegetation Site: VO = Open (50 X 70m) VF = Fenced (50 X 70m)
  - Site No.- 1. Chained Pinyon, Juniper (experimental)
  - 2. Chained Pinyon, Juniper (control)
  - 3. Plateau Sagebrush
  - 4. Valley Sagebrush
  - 5. Pinyon, Juniper (experimental)
  - 6. Pinyon, Juniper (control)
- Microenvironmental Stations
- SG-12 Proposed Core Hole Location
- A-13 Proposed Alluvial Core Hole Location
- NQ-7 Proposed Slant Core Hole Location
- Power Line
- 53 Spring or Seep
- Animal Trap Site (800 x 800 F)
- XXXXXXXXX Satellite Animal Trap Transects
- Deer Pellet and Browse Utilization Transects
- Ornithological Study Transects
- Waterfowl Systematic Observation Sites
- PSA & PSB Parasite Sampling Site
- Animal Track Count Transects
- Predator Scent-Post Survey Lines
- Prelease Core Hole Location
- Other Sensitive Areas

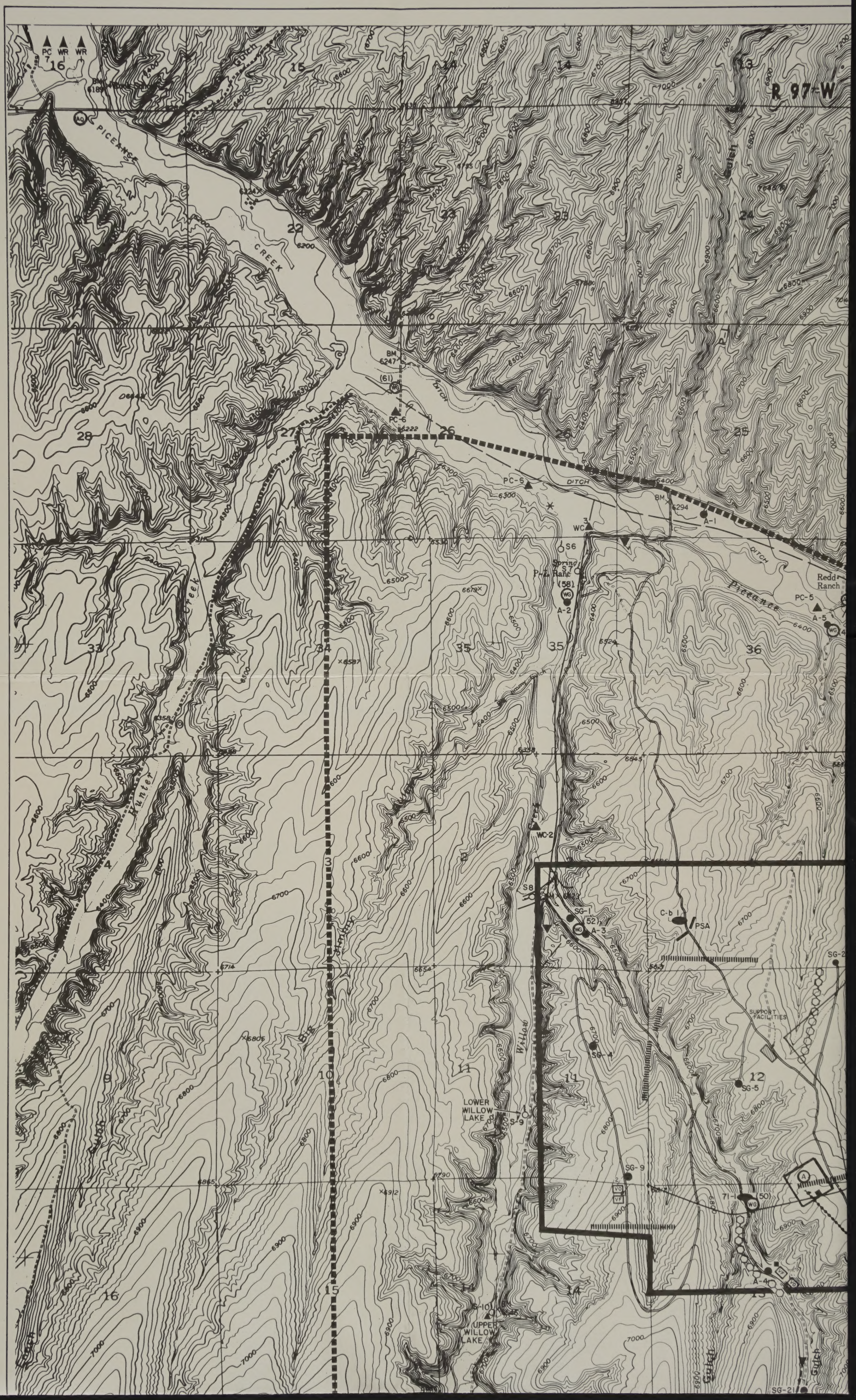
Drawn: 30 Nov 1974

0 1/4 1/2 1 MILE

OIL SHALE TRACT C-b
ENVIRONMENTAL AND EXPLORATION ACTIVITIES

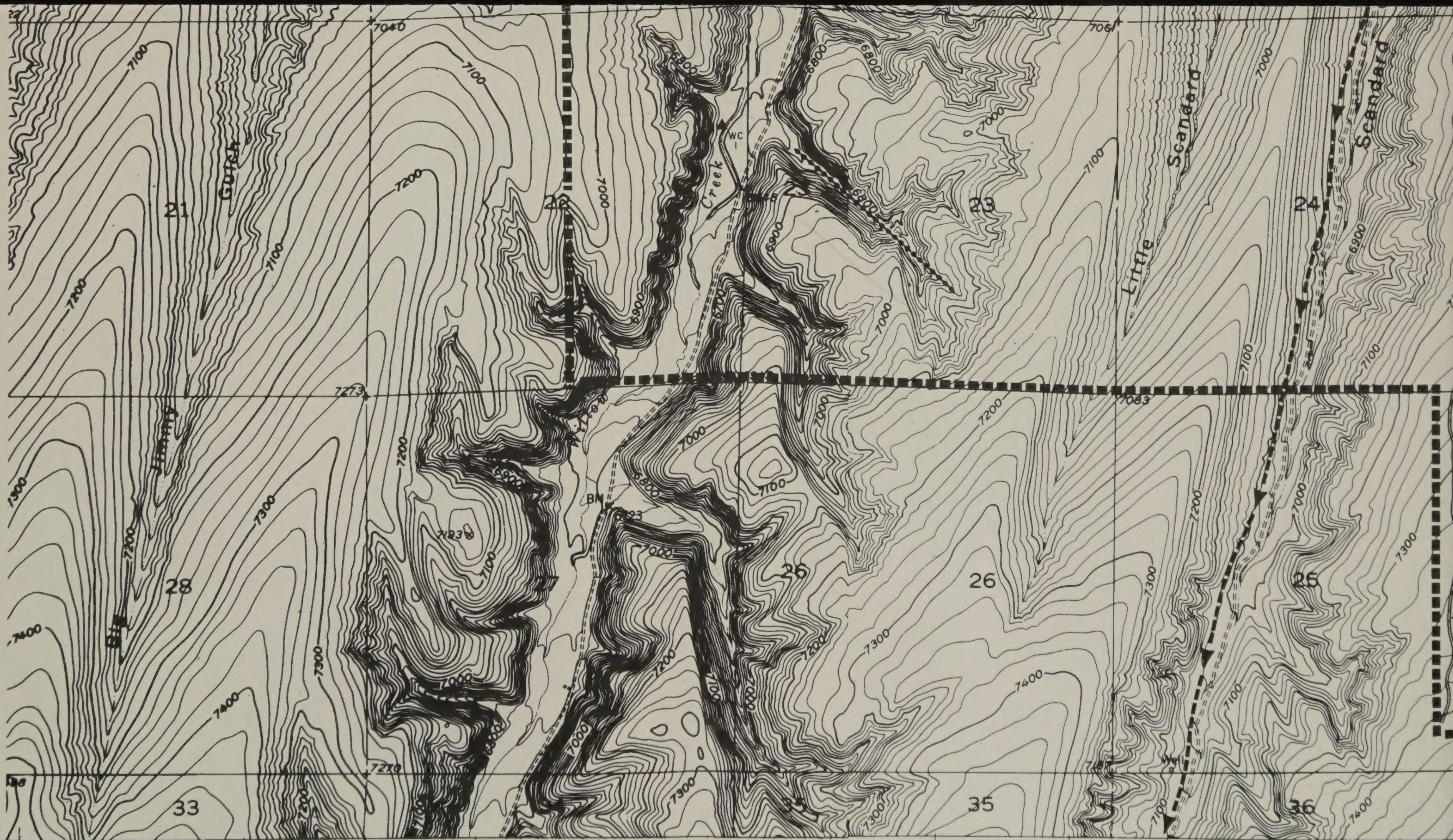
C-b SHALE OIL PROJECT

Ashland Oil, Inc.
Atlantic Richfield Company, Operator
Shell Oil Company
The Oil Shale Corporation



R 97 W
PICEANCE CREEK
Piceance
Redd Ranch
Spring
P-L Ranch
DITCH
Hunter
Creek
Willow
LOWER WILLOW LAKE
UPPER WILLOW LAKE
PSA
SUPPORT FACILITIES
Gulch
PC-5
PC-6
WC-2
A-1
A-2
A-3
A-4
A-5
SG-1
SG-4
SG-5
SG-9
S-9
S6
S8


R 96 W.
COLLINS GULCH
OVERLOOK
T 2 S
T 3 S
Gardenhire
Collins
Gulch
Creek
Piceance
DITCH
Walter Oldland
Ranch
Stewart Lake
Lower
Stewart
Lake
UPPER
STEWART
LAKE
Cottonwood
Gulch
Sorghum
Fed. 2-b
PC-1
PC-2
PC-3
PC-4
SC-2
SG-3
SG-6
SG-8
SG-11
SG-15
SG-16
SG-17
SG-19
SG-20
SG-10,10a
A-6
A-7
A-8
A-9
A-10
A-11
A-12
A-13
C-b 3
C-b 4
C-b2 (2b)
NQ-7
NQ-12
PSB
S1
S2
S3
S4
Well



LEGEND

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- Air Quality Meteorological
- Support Facilities
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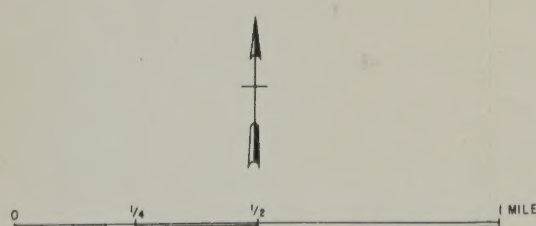
Drawn: 30 Nov. 1974



OIL SHALE TRACT C-b
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